NATURE

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"To the solid ground
Of Nature trusts the mind which builds for aye."—Wordsworth.

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Cancer.

A GOOD deal has been done in recent years to elucidate the laws of animal growth—the rules, that is, which determine that each individual animal grows, develops, and differentiates until its body has reached a certain size, with its various parts and organs in certain proportions and in certain relationships to one another. The deadly precision with which the 'normal' result is achieved is so commonplace that we wonder at it less than we do at the much rarer cases when the regulatory mechanism goes wrong. That is the naturalist's instinct. 'Treasure your exceptions' is, within reasonable bounds, a sound rule, and the study of unnatural forms of growth is as likely a road as any other to lead us to an understanding of normal development. Of all the varieties of abnormal growth, we know most about tumours, especially of human tumours, and more particularly of those which by their nature tend to kill the individual in which they grow and which we distinguish as 'malignant tumours' or 'cancer.'

The natural history of man is known far better than that of any other animal: an industrious worker may examine a hundred thousand individuals of some wild species; most people would think they had done pretty well if they had closely scrutinised five hundred. But the organised activities of public health authorities now keep under pretty close observation some 200 million people, and tell us, with tolerable if improvable accuracy, the reasons why they die from year to year and from childhood to old age. We know from these data that cancer is one of the chief causes of death in civilised countries in temperate climates, and we have a great mass of information about the sex,

age, occupation, and other circumstances of the people who die from it.

The whole 'cancer problem' is therefore of considerable interest from many points of view—biological, medical, and personal—and these are all represented in the report,[1] lately published, of the International Conference on Cancer, held in London last July under the auspices of the British Empire Cancer Campaign. The twenty-sixth annual report of the Imperial Cancer Research Fund also contributes once again its record of the steady, sober progress which that organisation has so consistently maintained, first under Dr. E. F. Bashford, and in recent years under Dr. J. A. Murray. Where does the problem now stand ?

A cancer grows from, and is composed of, cells of the body in which it arises. It differs from normal tissue in its gross morphology, in its minute structure, and in its functional relationships, but these differences are quantitative rather than qualitative. Anatomically and physiologically the degrees of resemblance and difference vary widely in different instances: some tumours are very like normal tissue, some are bizarrely different. All attempts to define any specifically malignant character have failed: Mr. H. G. Crabtree has lately shown that Warburg's criterion of a capacity for anaerobic glycolysis is not valid, since cellular overgrowths of an inflammatory nature show the same sort of metabolism. The most definite feature of cancers is their relative detachment and isolation in the co-operative community which is formed by the tissues and organs of the body. The normal anatomical relationships of epithelium and connective tissue, for example, are due to the mutual restraint of each tissue on the other: if a cancer starts in the epithelium, it is not held in check by the connective tissue: it defies the laws of normal growth and produces tissue which does not subserve the proper functions of epithelium towards the underlying tissues and the rest of the body.

Similarly, cancer cells are not subject to the ordinary rules of senescence. Growing old, and eventually so old that life ceases, is a function of the body as a whole, not of individual tissues. If a normal embryonic tissue is isolated from the rest of the body in artificial culture, it can be propagated by periodical transplantations for a time much longer than the natural life of the animal species from which it came, and probably indefinitely. A mouse cancer is physiologically isolated in an analogous manner: it never grows old, and by transplantation from mouse to mouse can be kept alive for many natural generations of mice, and probably for ever.

[1] John Wright and Sons, Bristol. 1928. Pp. 588.

Pieces of tissue which are in this way detached from the communal activities of the body as a whole are, as might be anticipated, useless. The fat in a fatty tumour is not available as a source of energy for the body; a tumour of stomach epithelium does not secrete gastric juice, nor is a muscular tumour of the uterus of any value in retaining or expelling a fœtus. But, which could scarcely have been predicted, they are also harmful; it is, after all, the great practical quality of cancers that they kill. In many cases they do this by interfering in a gross way with the normal working of the stomach or intestines or brain or lungs. But they kill with equal certainty if they do not involve any vital organ and, questionless, they produce some substance which is poisonous to the rest of the body, often shown most strikingly by the production of an extreme degree of wasting. Few attempts have been made to explain this general ill effect, and we really know nothing of its intimate mechanism. Why cancer kills is a very interesting question which still needs an answer. It may be that there is a biological principle that cells which are not with the body are against it.

Far more attention has naturally been given to the origin and causes of the dissociated growth. All the evidence goes to show that it is due to a reaction between the tissues and some external stimulation. Organisms exist only in relation to their environment: normal organisms react to a normal environment in such a way that each is in perfect adaptation with the other. In cancer there is something wrong with both.

There is no substantial evidence that cancer is due to any sort of parasite. Malignant tumours produce substances which can stimulate normal cells to take on a cancerous way of growth; in some ways they resemble the invisible viruses which are the causes of some infectious diseases; but these carcinogenic agents have never been found apart from tumours, and it seems most likely that they arise in and are the result of cancer rather than its cause. The cumulative indications, however, that cancer is caused by various forms of stimulation which we may group together as chronic irritation, become more and more impressive, and fresh examples of the association are continually being brought forward. Irritation involves cell injury and cell destruction, and any class of agents which can injure cells may evoke cancer as a response—mechanical, thermal, chemical, parasitic, and radiant injury are all effective. But

though a jagged tooth, swallowing food too hot, working in arsenic, being infected with the worm *Schistosomum*, and X-rays may all cause cancer, experiments on animals and observations on man agree in attaching special efficacy to soot, tar, shale oils, and other products of destructive distillation.

There are strong grounds for thinking that this is the environmental factor which connects a high cancer incidence with civilisation and town life. Man is an artificial animal, and he is evidently far from perfectly adapted to the surroundings which he makes for himself. Human and animal experience also agree in showing that cancer follows injury only after a long latent period, during which the irritation may or may not be continued. The interval in mice is of the order of one-third of their natural span of life: a corresponding period of 15 to 20 years is suggested by the human data. If man lived, like a wild animal, only for the years of his physical perfection and generally finished about 30 or 35, few people would have malignant tumours. They are not common until ages of forty and upwards are reached—a prime fact in their epidemiology which is consistent with the view that irritants are the most important stimuli of cancerous growth, especially when this mode of response is given better chances to emerge by man's unnatural habit of keeping himself alive a good deal longer than was intended.

Whether irritants produce cancer or not depends also on the tissues which are involved. Recent observations show in a variety of ways that the constitution of the irritated individual is far from immaterial. Experimentally it is easy enough to make malignant tumours with tar in mice, difficult or next to impossible in rabbits, rats, or guinea-pigs. Within the same species, races and individuals differ in the same way. Mice are so prone to develop 'spontaneous' cancers that the incidence of the disease may be observed in them as it may be in man. Some strains are more cancerous than others, and the original demonstration by the Imperial Cancer Research Fund, that a tendency to have cancer could be exaggerated by selective breeding, has been very fully confirmed by the massive observations of Miss Slye, Prof. Leo Loeb, and others. Races have been obtained in which nearly every mouse dies of cancer; other races in which cancer is almost unknown; and it is quite clear that the liability to respond to irritation by producing a cancer is a heritable constitutional quality, depending apparently on more than one Mendelian factor, and difficult to trace through man's promiscuous breeding.

We have also learned in recent years that these constitutional differences may be acquired as well as in-born. If a large number of mice are tarred to the same extent, the time at which they will develop tumours in response will vary widely: some individuals are much more refractory than others. If the cancers of the skin which first appear in the most susceptible animals are removed by operation, it proves to be exceedingly difficult or impossible to produce a second tar tumour in the same animal. Mice from which spontaneous tumours have been excised are equally refractory. The development of one cancer thus produces some alteration in the whole economy of the animal, which makes it everywhere less responsive to carcinogenic irritation.

These experimental facts are reflected in human experience. Multiple malignant tumours in one person are less common than they should be if the development of one had no relation to the development of others: cancers of the breast and of the uterus are so common that examples of the occurrence of both in the same woman should be fairly frequent instead of rare. The analysis of international statistics, in which a committee of the League of Nations has taken an important part, also suggests that relative freedom from cancer of one organ may be made up by relative abundance in another organ. Thus in England, Holland, Switzerland, and Japan the death-rate from cancer is about the same: in each case the absence of cancer of the breast and uterus in males is counterbalanced by a higher rate for cancer of the alimentary canal, so that the total incidence in the two sexes is the same. In Japan, cancer of the breast is relatively unimportant, but cancer of the uterus is so much commoner that the mortality from both is higher than in Holland or Switzerland. Through several lines of approach, therefore, we reach the conclusion that there is a cancerous diathesis affecting the body as a whole as well as a heritable liability for some particular organ to be involved.

The progress in our knowledge of cancer, its nature, causes, and cure, cannot from any point of view be regarded as unsatisfactory. The mystical ideas of thirty years ago have been replaced by a clear biological conception of stimulus and response. It cannot be long before we shall be able to define more closely the essential characters of effective stimuli on one hand and on the other the constitutional qualities which lead a tissue to give a cancerous response. The 'cancer problem' is far from solved, but it seems much more soluble as time goes on.

Eddington on the Nature of the World.

The Nature of the Physical World. By Prof. A. S. Eddington. (Gifford Lectures, 1927.) Pp. xix +361. (Cambridge: At the University Press, 1928.) 12*s.* 6*d.* net.

THE lectures endowed by Lord Gifford in 1887 for "promoting and diffusing the study of Natural Theology, in the widest sense of the term—in other words, the knowledge of God"—were delivered in 1927 in Edinburgh by Prof. Eddington. At the time they excited an interest which, even after allowing for the traditional intellectual fervour of the Scottish capital, must be regarded as altogether exceptional: and now that they are published, the interest is likely to become universal.

"I propose," Prof. Eddington says in the Introduction, "to discuss some of the results of modern study of the physical world which give most food for philosophic thought. This will include new conceptions in science and also new knowledge. In both respects we are led to think of the material universe in a way very different from that prevailing at the end of the last century." In the last four chapters he considers the position which the new scientific view should occupy in relation to religion.

Descriptions of the phenomena of atomic physics as given in popular text-books have an extraordinary vividness. We see nuclei surrounded by circulating electrons, which from time to time are tossed into higher orbits by X-rays or torn away altogether, and after hairbreadth escapes are again caught and fall back again. The success of this model in co-ordinating the facts of spectroscopy shows that it bears some analogy to the actual atom; but (as is made clear by wave mechanics) there is no real resemblance. The fall of an electron from one orbit to another is merely a conventional way of representing a particular change of state of the atom which cannot properly be represented by movements in space as macroscopically conceived. *Something unknown is doing we do not know what*—that is what the theory amounts to. The reason why it is fruitful is that our descriptions are not limited to unknown agents executing unknown activities, but include *numbers* scattered freely in the description. To contemplate electrons circulating in the atom carries us no further; but by contemplating eight circulating electrons in one atom and seven circulating electrons in another, we begin to realise the difference between oxygen and nitrogen. Out of the numbers proceeds that harmony of natural law which it is the aim of science to disclose.

So far, Eddington is just a Pythagorean. "The leading principle of Pythagoreanism," as Walter Pater said, "was the universality, the ultimate truth, of numerical law, analogous to the numerical laws of harmony in music: the finite (τὸ πέρας) or definable, with all the unity-in-variety of concerted music, ever controlling the infinite (τὸ ἄπειρον), the indefinite, formless brute matter of our experience of the world," and the plan of the whole book reminds us forcibly of what Proclus says of Pythagoras, that he "examined the principles of natural knowledge to the bottom, and investigated its theories in an immaterial and intellectual manner" (ἀΰλως καὶ νοερῶς). Let us see, then, how Eddington illustrates his view about the nature of exact science by analysing, in an immaterial and intellectual manner, an examination question.

"If we search the examination papers in physics and natural philosophy for the more intelligible questions, we may come across one beginning something like this: 'An elephant slides down a grassy hillside. . . .' The experienced candidate knows that he need not pay much attention to this: it is only put in to give an impression of realism. He reads on: 'The mass of the elephant is two tons.' Now we are getting to business: the elephant fades out of the problem and a mass of two tons takes its place. What exactly is this two tons, the real subject matter of the problem? It refers to some property or condition which we vaguely describe as 'ponderosity' occurring in a particular region of the external world. But we shall not get much further that way: the nature of the external world is inscrutable, and we shall only plunge into a quagmire of indescribables. Never mind what two tons *refers* to: what *is* it? How has it actually entered in so definite a way into our experience? Two tons *is* the reading of the pointer when the elephant was placed on a weighing-machine."

Similarly for the other data of the problem. Thus by the time the serious application of exact science begins, we are left only with pointer-readings. *Science is simply the linkage of pointer-readings with pointer-readings.*

The Victorian physicist felt that he knew just what he was talking about when he used such items as *matter* and *atoms*. Atoms were tiny billiard balls, a crisp statement that was supposed to tell you all about their nature in a way that could never be achieved for transcendental things like consciousness, beauty, or humour. But now we realise that science has nothing to say as to the intrinsic nature

of the atom. The physical atom is, like everything else in physics, a schedule of pointer-readings. The schedule is, we agree, attached to some unknown background, but what it is we do not know. Only in one case—namely, the pointer-readings of our own brains—have we an insight that is not limited to the pointer-readings: and that insight shows that they are attached to a background of consciousness.

Why not, then, suppose that the unknown background of all pointer-readings is something continuous with our mental nature, something of the nature of consciousness? Why should not the stuff of the world be mind-stuff? What knowledge have we of the nature of atoms that renders it all incongruous that the assemblage of atoms constituting a brain should be of itself a thinking object?

The doctrine that ultimate reality is of the nature of mind, or thought-content, is as old as Plato; but Eddington's approach to it is original and bears not much resemblance to that of the idealist metaphysicians. His lectures, coming from a physicist of the front rank, will penetrate where philosophers have never found a hearing; and how much need there is for teaching such as Eddington's may be realised when we compare him with (for example) Bishop Barnes, who, in his objections to the Catholic doctrine of the Sacraments, still seems to be dominated by the nineteenth-century physicist's conception of matter as something necessarily and entirely unspiritual.

Having swept away one of the two principal causes of tension between science and religion—namely, the association of science with materialistic philosophy—Eddington now turns to the other, namely, the deterministic character which has hitherto been attributed to physics, and the difficulty of reconciling scientific determinism with doctrines of human free will and responsibility. Here the solution is one that could not have been dreamt of twenty years ago—it is nothing more or less than a total denial of determinism in physics itself. "On the scientific side," he says, "a new situation has arisen. It is a consequence of the advent of the quantum theory that *physics is no longer pledged to a scheme of deterministic law.* Determinism has dropped out altogether in the latest formulations of theoretical physics and it is at least open to doubt whether it will ever be brought back. . . . The future is a combination of the causal influences of the past, together with unpredictable elements—unpredictable not merely because it is impracticable to obtain the data of prediction, but because no data connected causally with our experience exist."

The position is that the laws governing the microscopic elements of the physical world—individual atoms, electrons, quanta—do not make definite predictions as to what the individual will do next. These laws indicate several possibilities in the future and state the odds on each. In general the odds are moderately balanced and are not tempting to an aspiring prophet. But short odds on the behaviour of individuals combine into very long odds on statistics of a large number of individuals; and all the successful predictions hitherto attributed to causality are traceable to this.

The questions which have been referred to in this review are only a small proportion of those dealt with in what must be regarded as an epoch-making book. Considerable discussion may be expected, for example, over the doctrine propounded in Chapter xi., that Einstein's gravitational field-equations and Maxwell's electromagnetic field-equations are not controlling laws of physics, but mere truisms, the violation of which is unthinkable, like the law that $3+1=2+2$. I must confess myself unable to follow the argument here, especially as Eddington indicates (p. 237) that in his opinion the law of ponderomotive force of the electric field is *not* to be regarded as one of these truisms; for it is known (as is proved, *e.g.*, in *Proc. Roy. Soc.*, **113**, pp. 509-511; 1927) that the equations of ponderomotive force are merely mathematical consequences of Einstein's gravitational field-equations and Maxwell's electromagnetic equations.

In conclusion, we may express our satisfaction that Eddington has avoided two pits into which many other travellers in these regions have fallen. The first is indicated in his own words:

"A besetting temptation of the scientific apologist for religion is to take some of its current expressions, and after clearing away crudities of thought (which must necessarily be associated with anything adapted to the everyday needs of humanity) to water down the meaning until little is left that could possibly be in opposition to science, or to anything else."

If the Christian religion had meant no more than some of its modern expositions, need the early Christians have suffered martyrdom?

And the other, also in his own words:

"The religious reader may well be content that I have not offered him a God revealed by the quantum theory, and therefore liable to be swept away in the next scientific revolution."

E. T. WHITTAKER.

Science and Life.

Point Counter Point. By Aldous Huxley. Pp. v + 601. (London: Chatto and Windus, 1928.) 10*s.* 6*d.* net.

SCIENCE, by flinging into the lap of an unprepared world an over-rich and embarrassing assortment of food for thought, must be held responsible for the mental indigestion from which the world is suffering. It is not surprising, considering the bewildering array of new knowledge and the number of new theories spread before us, that the only beliefs are unbeliefs, that traditions are anachronisms, and precedents ephemeral things. This is not an age of reason but of unreason. We are attempting to explain everything in terms of psycho-physiologico-physico concepts, but have so far succeeded only in making life more complicated for the majority. No great synthesis of our new knowledge has yet been attempted upon which to base a guiding philosophy for puzzled mankind. Mr. H. G. Wells may yet accomplish this task for us, but that it has still to be done is the opinion held by many, an opinion which will find reinforcement in this latest volume by Mr. Aldous Huxley, in which nearly every character is shown either floundering or detached.

"Point Counter Point" will not satisfy those who want novels based on the Richardson model, "a story wrought round the passion of love to a tragic or joyous conclusion," or that of Scott, who combined excellence of characterisation with the harmonious development of his plots. Mr. Huxley flouts such conventions. He conveys the impression that the principal character of the book is outside it. Interestingly and provokingly drawn as they are, we have not to read far to become less interested in his characters than in himself, less interested in their outlook on life than speculative about his. He introduces character after character into his pages, psycho-analyses them, and then lays them aside once they have served the purpose either of explaining their reactions to environmental stimuli in terms of old or new theories of behaviourism, or as vehicles for the expression of his varied and conflicting thoughts on different types. His analyses are brutally realistic, although it is probable that, by restricting his field of choice to exaggerated types obsessed by sex, he loses some of his effect. At the end he leaves us wondering whether he intends to point a moral or merely to record his observations concerning the disastrous effects on some people of the breakdown of tribal authority and the waning influence of taboos resulting from the impact of science on society. But he makes it clear that he despises most of the devices by which most writers maintain interest in their characters, while at the same time showing more than once that he could, if he would, write a thrilling 'best-seller' conforming to pattern.

However, we need not be concerned here with Mr. Huxley's merits or demerits as a novelist. They have been dealt with elsewhere by others whose business it is to tell the members of the general public what they should think about the books written for them. What should interest us is his attitude towards science and scientific workers, and his assumption that the creative scientific research worker is something essentially different and less human than the creative artist. It is for his explanations of, and his onslaughts on, science, rather than for his studies in psycho-pathology, that this volume should be read by all who consider themselves specialists in any branch of science. Having been for years held up to the wonder and admiration of the world by Mr. H. G. Wells, scientific workers may need the corrective to their self-esteem which Mr. Huxley supplies. Rampion, his artist, remarks:

> "The lizards died of having too much body and too little head, so at least the scientists are never tired of telling us. Physical size is a handicap after a certain point. But what about mental size? These fools seem to forget that they're just as top-heavy and clumsy and disproportioned as any diplodocus. Sacrificing physical and effective life to mental life. What do they imagine's going to happen? . . . They're just marching towards extinction; . . . they're marching the rest of the world along with them."

Rampion and his wife, incidentally, are the only really attractive characters Mr. Huxley introduces into his six hundred pages, though it must be confessed that Rampion's fulminations against physical research—the search for "non-human-truth" as he calls it—becomes somewhat tiresome, partly through repetition, but mostly because all the explanation given of the other kind of truth, "human truth," is that it is something you discover by living—"living completely, with the whole man"—to which any interpretation can be given.

Apparently the assumption is made that persons like scientific specialists, absorbed in an intellectual occupation for a great deal of their time, are necessarily consistently "mental, conscious, and voluntary," and never "physical, intuitive, instinctive, and emotional," in their reactions. The fact is that most modern scientific specialists are ruled by their prejudices and emotions in everything except

their own small branches of study. They are neither rational nor realistic in most affairs of life, merely normal, which is a real misfortune to the world and the civilisation which is due to their discoveries. Science has lost the art of leadership, if it ever possessed it. The scientist is afraid to be different, timidly afraid to accept the implications of the results of his own work and acquired knowledge, afraid to suggest that his own outlook of inquiry and patient observation, fearlessness to discard outworn or useless hypotheses, all of which be brings to bear on his own research, could with advantage be applied to our political, social, and economic institutions. Perhaps, however, indifference and not fear is the cause of it.

Mr. Huxley may be justified in stating that " the real charm of the intellectual life—the life devoted to erudition, to scientific research, to philosophy, to æsthetics, to criticism—is its easiness." . . . Easiness breeds indifference. It is this indifference which makes for misunderstanding, for the oft-expressed irritation of the non-specialist with the specialist, and for the suggestion that the research worker—the really creative research worker—is less of an artist than other specialists—sculptors, painters, poets, and the like. Mr. Huxley gives me the impression that he has weighed science in his scales of human values and found it wanting. But is science responsible for that ?

A. G. CHURCH.

Archæological Investigation in Guernsey.

The Archæology of the Channel Islands. By T. D. Kendrick. Vol. 1 : *The Bailiwick of Guernsey.* Pp. xxiv + 273 + 20 plates. (London : Methuen and Co., Ltd., 1928.) 25*s.* net.

TO anthropologist and historian alike the Channel Islands are rich in interest. The last vestige of the Duchy of Normandy—there the King is still officially the Duke—they possess a constitution of their own, and they have their own language, not a patois, but a lineal descendant of old Norman French, of which it retains the pronunciation and vocabulary, to the confusion of French-speaking visitors. The racial affinities of the inhabitants are by no means clear, though this is perhaps due to the fact that their physical characters have not been adequately studied. A series of measurements taken in Jersey more than thirty years ago would not now be regarded as entirely satisfactory in technique, and the conclusions then drawn require reconsideration in the light of later theory. It is, however, patent that at least two racial strains are present, a fair and a dark breed. Cultural affinities with Brittany are present ; and attempts have been made to show that the place-names embody a Celtic element. This latter contention is more than doubtful, and there is little convincing evidence for anything which cannot be derived from Norse or early Norman French. For the affinities of the fair strain it is probable that we should look to the Norse type, and especially, in view of historical relations, through the Contentin, while connexion with Brittany may reasonably be correlated with the short, dark, long-headed man who forms the substratum of the population on the north-western fringe of Europe. The fair type, to the eye at least, appears quite distinct from the fairer Breton, who possibly may derive from a constituent in the later immigration of Celtic-speaking peoples from Britain.

The first volume of Mr. Kendrick's " Archæology of the Channel Islands " deals only with the Bailiwick of Guernsey, that is, the Islands of Guernsey, Alderney, Sark, Herm, and attendant islets. Jersey here obtains incidental reference only, and will receive attention in a second volume to be published later.

The history of archæological discovery in the islands is exceptionally important in its bearing upon the nature of the evidence. So many of the monuments and early finds have now disappeared that for our knowledge we are dependent upon the work of early explorers, and especially of F. C. Lukis, to whom Mr. Kendrick's tribute and constant references do no more than justice. The greater part of his record remains still in manuscript, but it has been used freely by the author, and it will always be the basis and starting-point of any work on the archæology of the islands. Lukis began his archæological investigations in the first decade of the nineteenth century, when he assisted in the excavation of the great passage grave of La Varde by Jean Gosselin, whose paper in *Archæologia* in 1811 is the first published reference to the prehistoric remains of Guernsey.

Archæologically, the Channel Islands are profoundly interesting. Though Guernsey and its attendant islands show no evidence of palæolithic man, in Jersey a human tooth discovered in a cave at St. Brelade's Bay bears witness to the extension of Neanderthal man to the islands. Considering the area of the islands, megalithic remains were very numerous ; they present certain resemblances to those of south-west Britain. A large and important bronze hoard found in Alderney shows relation with the British Bronze Age, and a gold

torque found in Jersey is similar to those of Ireland. It is probable, therefore, that the islands served as a gathering place and entrepôt along the lines of prehistoric trade. This may explain the discrepancy between the numbers and distribution of stone axes and of megalithic monuments in the islands, the latter being most frequent in Alderney and Herm, while the largest number of stone axes, as might be expected, is found in Guernsey. Mr. Kendrick thinks that the islands of Alderney and Herm may have been regarded as specially sacred. But Alderney at least, notwithstanding its dangerous sea passage, is on the obvious line of communication from the Continent to Britain, and it may be remembered that generally monuments, especially funerary monuments, tend to cluster around trade centres and along trade routes.

The difficulties enumerated by Mr. Kendrick of interpreting archæological evidence in any insular area are well illustrated in the Channel Islands. The most reasonable inference is that they were, on the whole, intensely conservative over a long period, but along certain lines admitted local development. Presumably this is the explanation of certain details in which the Channel Island finds are unique, such as the curious form of long-nosed stone pick and a certain type of pottery. Yet they were not entirely free from outside influence. This is more marked in Jersey than in Guernsey, no doubt owing to the fact that within the period of human occupation an elevation of the land has twice joined Jersey to the Continent. This would account for palæolithic culture being present in Jersey alone. If influx took place at the time of the second elevation, as is suggested by the evidence, a knowledge of seafaring would then have enabled man to pass to Guernsey and the adjoining islands. For there the history of man, so far as we know, begins with the megalithic period and the culture is predominantly megalithic throughout.

The Guernsey group shows transition from the early Bronze, through the full Bronze, to the late Bronze and Iron Ages. Yet progress throughout is along a line of development from the great communal burial places in the passage graves with which the cultural history begins. It is influenced by outside relations rather than modified by the intrusion of a new civilisation. Thus, though cremation appears in these islands, they have nothing to show like the round barrow and the Hallstadt cemetery of Jersey until the time of a La Tène settlement from Gaul in the century preceding our era. On the other hand, the evidences of outside influence are many. The absence of flint *in situ* and its occurrence in the form of beach pebbles only mark out the finer implements of this material, such as the Pressigny types, as imported. One flint axe is of Scandinavian character. The remarkable hoard of two hundred objects of bronze found at Longy in Alderney, already mentioned, includes many British in type. But more marked are the relations with Brittany, to which constant reference has to be made throughout Mr. Kendrick's text, justifying the conclusion to which he leans that the Channel Islands predominantly represent an outpost of the megalithic culture of that area.

Among the more remarkable of the archæological remains described here are the statue menhirs carved in the representation of a human female form—a type of the mother goddess. A carving on the underside of a stone roofing a megalithic monument from its position—part of the carving overlies the upright on which it rests—is obviously older than the structure of which the stone forms part. These statue menhirs are sometimes called 'neolithic,' but, after a comparison with similar monuments elsewhere, notwithstanding their archaic appearance, the author is inclined to consider their age as uncertain.

Mr. Kendrick has marshalled his facts with consummate ability, and makes them tell a consistent story so far as they carry him within the limits he has set to the subject matter of this volume. For his discussion of their broader relations we must await his second volume.

Nitroglycerine Explosives.

Nitroglycerine and Nitroglycerine Explosives. By Dr. Phokion Naoum. Authorised English Translation, with Notes and Additions by E. M. Symmes. (The World Wide Chemical Translation Series, No. 1.) Pp. xi+469. (London: Baillière, Tindall and Cox, 1928.) 31*s.* 6*d.* net.

THE translator of Dr. Naoum's well-known work has rendered useful service in making it available to a wider circle of readers, containing as it does a fuller collection of information on its subject than any other work in the English language. Originally published in Germany in 1924, it gives an account of the great industry built on the foundations laid in 1847 by Sobrero, the discoverer of 'nitroglycerine,' and by Nobel, who in 1862 first commenced its manufacture on a technical scale. Not only is this substance of great value to humanity for peaceful purposes, but it is also of vital importance in the manufacture of propellants as munitions of war, to an extent probably not

foreseen by Nobel, the founder of the Nobel peace prize, who died in 1896.

The claim of the author of this book to include "all matter worth while on the subject" is not fully justified, in view of the omission of information on developments in this branch of explosives technology which became available in the years preceding and immediately following the War. To a slight extent this has been remedied by the translator by the insertion of numerous footnotes, but these are extremely brief, and for the most part refer to differences between German and American practice. The origin of the book is evident from the occasional presence of such phrases as "the never-to-be wholly avoided blown-out shots," but with very few exceptions the translation is excellent.

Following a short historical summary of the development of the nitroglycerine and dynamite industry, the book is divided into three parts, the first of which deals with the manufacture, uses, and properties of nitroglycerine. On page 11 we read the surprising statement that "nitroglycerine explosives as munitions achieved little importance," but on the next page we find that "In the World War nitroglycerine was the most indispensible [*sic*] component of munitions."

The manufacture of nitroglycerine as carried out in Germany at the works of the Dynamit-A.G. vorm. Alfred Nobel, of whose central laboratories in Hamburg Dr. Naoum is director, is fully described, but only very brief footnote references are made to the very different practice followed in the U.S.A. The Nathan, Thomson, and Rintoul nitrator-separator process used in Great Britain and elsewhere is described with the aid of a diagram from which the reference letters mentioned in the text are omitted. In the chapter referring to the denitration of spent acids, the references are all to early pre-War plant, and make no mention of the developments made during the War, records of which were available in 1920. The same criticism applies to the chapter on the physical and chemical properties of nitroglycerine as an explosive, no reference being made to modern methods of measuring explosion pressures by the application of the Hopkinson pressure-bar, and the piezo-electric gauge.

Part 2 contains a description of the preparation and properties of homologous and related nitric esters, many of which possess valuable properties from the thermo-chemical point of view, but have failed to find a permanent place in the explosives industry owing to their high cost of production, or defective properties of volatility, hygroscopicity, etc. Of special interest are those esters used in the production of 'non-freezing' explosives; of these, 'nitroglycol' has only recently become an economic possibility, owing to the development of methods for the manufacture of ethylene-glycol from the ethylene in natural gas.

Part 3 details the manufacture and properties of the numerous series of explosives containing nitroglycerine which are used for blasting purposes, but does not include the non-brisant mixtures used as propellants. The mis-translation of 'brisanz-granaten' on p. 281, as 'brisant grenades,' gives rather a restricted impression of the importance of trinitrotoluene–ammonium nitrate mixtures as shell fillings during the War. The development of gelatinised explosives following on Nobel's discovery of the gelatinisation of nitrocellulose by nitroglycerine marked a great improvement on the dynamite type of explosive, and finally led to the introduction of smokeless propellants containing nitroglycerine. A brief description of the manufacture of nitrocellulose or collodion cotton for this purpose omits all mention of the Nathan and Thomson displacement pan method, which was introduced more than twenty years ago, and has since been widely used.

The description of ammonium nitrate as an endothermic explosive compound, and of tetryl as tetra-nitromethylaniline, should be corrected in future editions.

A large number of tables are given showing the composition and properties of nitroglycerine explosives, but these have not all been brought up-to-date; for example, out of eleven British Permitted explosives quoted, only three are now on the Permitted list.

The book is well printed, and contains few printers' errors. With the reservations mentioned above, it can be recommended to all who are interested in the development and products of the nitroglycerine and nitroglycerine explosives industry.

R. C. G.

The Mechanism of the Nervous System.

The Basis of Sensation: the Action of the Sense Organs. By Dr. E. D. Adrian. Pp. 122. (London: Christophers, 1928.) 7*s.* 6*d.* net.

IT is not always easy to induce the worker who is making great discoveries to put them into a book: and the thanks of the scientific world are due to the University of London for persuading Dr. Adrian to give last year the short course of

lectures which formed the starting-point of this little monograph.

Of all the work recorded in the field of physiology in recent times, none is more beautiful in itself, more striking in its historical derivation, more pregnant with possibilities of future development, than that which Dr. Adrian with such engaging modesty and humour describes herein. To have heard the roar in Dr. Adrian's loud-speaker of the amplified afferent impulses flowing up from the heart in the depressor nerve, to have seen the sensory waves in a single nerve fibre from the frog's skin chasing each other like little imps across the screen of Matthews' oscillograph, is to have one's imagination stirred by the progress which has been achieved in the last few years in knowledge of how the nervous system works, and by the picture of the complex scurrying activity on which sensation and consciousness are built. The scientific basis of this achievement is described very shortly but very clearly and with great charm in this book.

It has long been realised that a state of continuous activity cannot be produced in a nerve by artificial means. The only form of message known to occur in a nerve was that of which the fundamental unit is the single nerve impulse, a short wave propagating itself at high speed by what are presumably electro-chemical processes. The activity of a nerve was no more continuous than that of a machine gun: the frequency with which its messages could be carried was similarly limited; after a single impulse, a 'refractory' period occurred during which no other impulse could pass. No proof, however, was at first forthcoming that natural activity in the living body did not invoke another kind of process, one of a continuous nature not involving a stream of discrete waves in the transmitting medium. It is still not certain that such continuous states of activity do not occur: it *is* certain, however, that a large part of the normal functioning of the nervous system depends upon a succession of separate impulses in the nerve fibres exactly similar in nature to those evoked by the physiologist in his studies of isolated nerve. For some years this conclusion has been obvious for the case of motor impulses to the skeletal muscle: Dr. Adrian has made it equally certain for the afferent impulses from the sensory end organs, and in recent work (not referred to in this monograph) has discovered how contractions are graded by the frequency of the impulses which reach the muscles along their motor nerves.

In 1914, Keith Lucas delivered a course of seven lectures at University College, London, and these, after his death at Upavon in 1916, were embodied in a book, "The Conduction of the Nervous Impulse," in a foreword to which Dr. Adrian speaks of himself as "one whose pride it is to regard himself as a pupil of Keith Lucas." Dr. Alexander Forbes, of Harvard, would with equal pride regard himself as a pupil both of Lucas and of Sherrington, and he was among the first to show objectively the discontinuous nature of the afferent messages of the proprioceptive system. The justice of this pious regard for Lucas's memory will be seen in Dr. Adrian's own book, where, suitably modified in the sensory organs, those properties of the nerve fibre which Lucas discovered are shown to be "the basis of sensation." In its skill and subtlety, in the judgment and ingenuity displayed in experiment, no less than in the fineness of its exposition, the work of Adrian is a worthy memorial to Lucas.

The achievement of recording a single wave of action potential in a single nerve fibre, which is the ultimate basis of this work, was made possible by modern developments in valve amplification. In Dr. Adrian's words: "It is now possible to work with a 5000 fold amplification on an input change of a few microvolts without danger of interference from unsteadiness in the amplifier." He pays an amusing tribute to the importance of the amplifier in his work: "When the academic scientist is forced to justify his existence to the man in the street he is inclined to do so by pointing out the essential part played by academic research in the development of our modern comfort. It is only fair, therefore, to point out that in this case the boot is on the other leg and the academic research has depended on the very modern comfort of broadcasting."

Dr. Adrian's work, however, will not be allowed long to remain without its own applications. It is interesting to find how this, the most academic branch of scientific physiology, pursued for purely scientific ends, has suddenly in Dr. Adrian's hands broken out into a region where neurology and medicine cannot fail, in a few years, to gain much by contact with it. Within a short space of time it may well prove as fundamental as the work of Sherrington and Magnus. To a mere physiologist it would seem that psychology also might have much to learn from it. How do our sensations differ in intensity? By the frequency of the impulses started in the end organs. How do we 'get used' to external changes? By the 'adaptation' of the end organs, which is seen in its extreme form in the nerve fibre itself. In Chapter vi., Dr. Adrian deals gently with behaviourists on one hand and idealists on the other: he is much too clever

to take sides with the one or the other, and after poking fun at the statement that "the brain secretes thought as the liver secretes bile," he concludes that "it does not matter very much whether we regard the relation of matter to mind as inexplicable or as needing no explanation." "There is a relation of some kind between nervous impulses and sensation, and we can discuss this without attempting to decide how, or whether, the one can 'cause' the other." After which he returns, in the manner of physiologists, to a consideration of the facts of his experiments. A. V. HILL.

Our Bookshelf.

(1) *How you Began: a Child's Introduction to Biology*. By Amabel Williams-Ellis. Pp. 96. (London: Gerald Howe, Ltd., 1928.) 2*s*. 6*d*. net.
(2) *A First Biology*. By Prof. S. Mangham and Prof. W. Rae Sherriffs. Pp. viii + 184. (London: Sidgwick and Jackson, Ltd., 1928.) 2*s*. 6*d*.
(3) *Fundamentals of Biology*. By Prof. Arthur W. Haupt. (McGraw-Hill Publications in the Zoological Sciences.) Pp. xii + 358. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1928.) 15*s*. net.

THESE three volumes may all be said to be books intended to introduce biology to pupils in schools. Mrs. Williams-Ellis's book is intended for young children of about seven or eight years of age. The volume by Mangham and Sherriffs is supposed to be for older boys and girls before they enter a university; whilst Dr. Haupt's "Fundamentals of Biology" is a reprint of lectures given to freshmen in New York, but the intellectual level attained by American freshmen is lower than that attained in the upper forms of the science side in schools in England.

Mrs. Williams-Ellis's book is preceded by a flattering introduction by Mr. J. B. S. Haldane. The book is beautifully written, and is an attempt to describe to young children the general course of human development interpreted in the light of the recapitulation theory, and the view that the essence of life is striving or desire. The child is told that he played at being a fish before he decided to become a man, and so on. Mr. Haldane considers that Mrs. Williams-Ellis's account of evolution is more nearly correct than those recently published by two scientific men. We do not know to what accounts Mr. Haldane refers, but Mrs. Williams-Ellis's account resolves itself into 'chance variations.' The late Dr. Bateson said "there are only two possible explanations of variation—chance, or the reaction of the animal to the environment." We prefer the latter, and believe that Mr. Haldane will also in the course of time.

The other two volumes give a mixture of chapters on animals and plants, and we suppose that the authors imagine that this is the easiest method of initiating young people into the study of biology. Many school teachers are, as a matter of fact, obsessed with this idea. Nevertheless, we hold that it is a profound mistake. That animals and plants are ultimately derived from the same stock, no biologist would deny: there is a level—that of the Flagellata, where they grade into one another. From this starting-point, however, evolution has pursued totally different courses in the two kingdoms, and it is most confusing to place side by side, as Mangham and Sherriffs do, reproduction in the higher plants with its concealed alternation of generations and that of animals. Haupt is not so blameworthy, for he gives a rapid sketch of plants just before proceeding to animals. The only proper way to study either animals or plants, in our opinion, is the way introduced by Huxley, namely, the examination of a series of types, and as we are animals and not plants, it is easier to begin with animals and then proceed to plants. Haupt, as might be expected from New York, devotes a disproportionate amount of space to Morgan and *Drosophila*. We hope that after Miller's exposition of the pathogenic character of the *Drosophila* mutations, this nightmare will gradually vanish from elementary text-books as an illustration of the "fundamental laws of heredity." E. W. M.

Truck Crop Plants. By Dr. H. A. Jones and Dr. J. T. Rosa. (McGraw-Hill Publications in the Agricultural and Botanical Sciences.) Pp. xiv + 538. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1928.) 25*s*. net.

VEGETABLE growing on a large scale at some distance from a market has assumed such proportions in the United States that certain universities have established divisions of 'truck-farming,' to guide the development of the system along the most economical and profitable lines both as regards cultivation and marketing. The economics of the manuring of truck crops is still in the experimental stage, but the growers are fully alive to the importance of controlling insect and plant pests.

Owing to the distance from market, the appropriate selection of crops is all-important, in order to obtain the essential correlation between the adaptation of the crops to soil and climate and the expected time of marketing. The development of truck farming has largely run parallel with improvement in transport systems, and the installation of refrigerating cars has done much to open up still more distant markets. As the crops are perishable, there is danger of loss from over-supply, and the possibility of competition between truck crops and the local supply in any district needs careful consideration. It seems probable that future advance in truck farming lies in production at lower costs rather than in higher selling prices, entailing concentration on intensive cultivation on land already cleared.

The variety of crops suitable for the purpose is somewhat limited, the most important genus being *Brassica*, which alone provides many species of

great economic importance. The general methods of treatment of each crop, from seed to harvest, vary considerably, and are outlined in this volume, sufficient illustrations and tables being provided to emphasise the salient points in crop development, manuring and marketing, and to provide a useful guide to the reader.

(1) *Rovers and Stay-at-Homes*. By Maribel Edwin. Pp. v+181. (London and Toronto: J. M. Dent and Sons, Ltd.; New York: E. P. Dutton and Co., 1927.) 5*s*. net.

(2) *African Jungle Life*. By Major A. Radclyffe Dugmore. Pp. viii+246+8 plates. (London: Macmillan and Co., Ltd., 1928.) 15*s*. net.

(1) IN these short tales, Mrs. Edwin has succeeded in capturing again the fine feeling of her earlier book. The stories are written for young children, and are marked by delightful simplicity of word and narrative. Each story gives a charming and accurate impression of the ordinary life-story of a common British creature—seal, sparrow, rat, seagull, eagle, and red-deer are typical samples. Lively pen sketches by M. M. Howard decorate almost every page, but the artist has an exaggerated notion of the amount of leg which a Scottish kilt may properly expose.

(2) Major Dugmore has chosen a series of silhouettes of African jungle life, and round them has written and illustrated a book which, while not specifically addressed to the young, will entrance both them and their elders. His personal touch with the jungle gives vividness, freshness, and accuracy to his stories of the adventures of the selected creatures—elephant, lion, buffalo, rhinoceros, and giraffe—and it is gratifying to read of the success which restrictive game laws, animal reserves, and, not least, enlightened public opinion, have had in preserving the wild fauna and increasing the numbers of innocuous creatures like the giraffe.

Major Dugmore is less happy in his arguments against the advocates of protective coloration, though his actual experiences must be given due weight; when, for example, he suggests that the winter change of the Arctic hare is not protective, because the hare retains its black eye, he forgets that a black eye is surely less conspicuous in snow than a complete brown hare, and that the pigmentation of the retina is an essential to the best vision.

The Earth and its Rhythms. By Prof. Charles Schuchert and Clare M. Le Vene. Pp. xvi+410. (New York and London: D. Appleton and Co., 1927.) 15*s*. net.

OF the many recent attempts to present popularised geology to the general reader, most of which have come from the United States, this is undoubtedly by far the most successful. The book is attractive in style and make-up; beautifully adorned with illustrations; well proportioned in its matter; and authoritative in its facts. The authors are fully aware of the difficulties that stand in the way of interpreting the processes of geology and the principles of evolution and earth-history to the non-scientific mind. They point out that the book is not intended for the geological purist, and that if there are any generalities that may offend him, he can best spend his spare time in explaining the exceptions that outcrop in the field of generalisations.

The geological purist may, nevertheless, safely recommend the book to any of his friends who may wish to absorb from our common intellectual heritage some knowledge of the record of the rocks. A little more than half the book deals with the architecture of the earth's crust, the fashioning of the raw materials into scenery, and the endless interplay of internal and external agencies. A chapter on geological time then introduces the dark ages of earth history, and the remaining chapters describe the dramatic procession of life with the skill that is to be expected of Prof. Schuchert. The book concludes with chapters on the ice ages and the coming of man. Authors and publishers are to be congratulated on a co-operation that has notably enriched the popular literature of science.

The Ramblings of a Bird Lover. By the Rev. Canon Charles E. Raven. Pp. xvi+186+31 plates. (London: Martin Hopkinson and Co., Ltd., 1927.) 10*s*. 6*d*. net.

AFTER reading this book, the two things the reader finds impressed upon him are these: first, that the author will insist on commencing most of his sentences with 'and' and, secondly, in spite of the weakness of his English, how very charming it all is. One finds that Mr. Raven can turn the catching of a gurnet into a poem of bliss, or can write a most interesting article on fish-bait. All that the author tells us in his book are things most of us knew in our early childhood, yet he awakens in us a fresh delight in our own knowledge.

The illustrations are almost as charming as the letterpress. The printing is good, and the general get-up of the book quite satisfactory. If the reader is irritated by the 'ands' when he starts reading, by the time he puts the book down he will be only too anxious for more.

Practical Vegetable Growing. By J. W. Morton. Pp. 180+8 plates. (London: Ernest Benn, Ltd., 1928.) 10*s*. 6*d*. net.

THIS is an excellent book, by an author who understands the practical side of the cultivation of vegetables. We are in agreement with his comment that far more knowledge may be definitely obtained from careful reading than is realised by the majority of those whose living depends upon the land. Here there is much to be gleaned that will encourage the market gardener, as well as those who work on allotments or maintain small garden plots in outer London and suburban areas. Cultivators in the last category are increasing in number without doubt, and have a special freemasonry of their own to boot.

The book has several useful illustrations, whilst the vegetables dealt with have been taken in alphabetical order. There is a satisfactory index.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Oscillation in Ultrasonic Generators and Velocity of Longitudinal Vibrations in Solids at High Frequencies.

THE increasing use of piezo-electric quartz for the stabilisation of radio frequencies has promoted many investigations of the vibration of the quartz. In the last few years a mass of information has been accumulated disclosing the complexities of vibratory modes and types which may exist simultaneously in one and the same crystal plate or rod. Along with the longitudinal, flectural and torsional oscillations may exist, as well as overtones of any or of all. In this connexion mention may be made of the experiments of Cady, Tawil, Dawson, Harrison, Hund, Giebe and Schiebe, Meisener, Ny Tzi Ze, Crossley, Dye, and others.

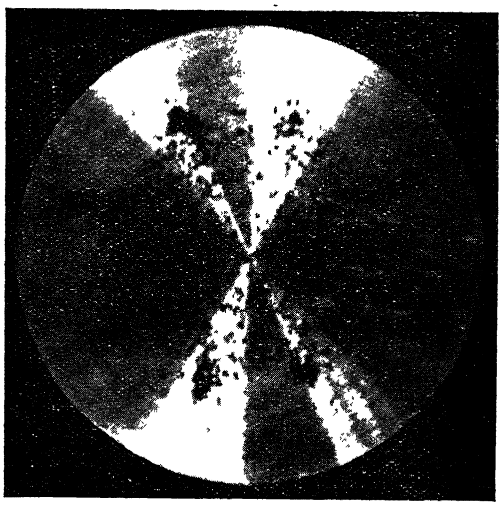

FIG. 1.

It is obvious that if the quartz is cemented to metallic plates or rods, as in ultrasonic generators, when vibrating it can transmit its motions to these bodies, and at very high frequencies, in the plates or rods themselves additional complicated oscillations may arise. A result is that often irregularities of distribution of amplitude, energy, and phase exist at the face of any ultrasonic radiator. Experimentally this was shown by the writer and assistants (*Trans. Roy. Soc. Can.*, **19**, p. 187; 1925) by surveying the energy distribution near the face of an ultrasonic generator operating in water, frequencies around 140,000 cycles per second.

A study carried out in this laboratory last year by Mr. Sproule on the behaviour of dust particles on the ends of vibrating metal rods, held vertically, and set into high frequency vibration by active quartz, revealed interesting examples of very complicated vibratory types. At certain resonant frequencies the dust arranged itself in patterns similar to some of Chladni's figures; four-, six-, eight-, and twelve-pointed stars could be obtained. At certain frequencies the particles were observed to move continuously in a circle about the centre of the section, sometimes those near the outer edge moving in a clockwise direction and those nearer the centre moving anti-clockwise. At times little whirls of dust were formed off centre. Evidently torsional vibrations and radial vibrations of other types could be set up in the rod. The photograph (Fig. 1) shows an example of an 8-pointed star so obtained. Here the rod was of duraluminum 5·1 cm. in diameter and 48·1 cm. long; frequencies of experiment ranging from 84,000 to 140,000 cycles per second.

Such work shows that very cautious judgment must be exercised when determining a resonant frequency, particularly the overtones, of any vibratory type; and mathematical computations of energy output, based on theoretical data alone, or on measurements taken near the radiator, or in any confined space in which the radiatory operates, may easily be misleading.

However, in the case of longitudinal vibrations of a rod of solid material set into high frequency oscillation by a piezo-electric plate, this method may be used, with due caution, to determine the velocity of sound in, and Young's modulus of, the rod at the frequencies of the fundamental note and lower overtones. Pierce, by setting rods of metallic alloys into longitudinal vibration by magnetostrictive action, has recently carried out very precise determinations of the same kind (*Proc. Amer. Acad. Arts and Sciences*, vol. 63, No. 1; April 1928).

For the natural modes of vibration of a free rod, the length of the rod is equal to an integral number of half wave-lengths ($l=k\ \lambda/2$); and the velocity $V=\sqrt{E/d}$ when the rod is thin (r/l small, for a circular section). But possible corrections may have to be applied in case of varying frequency and changing ratio r/l on account of the lateral inertia of the rod. For example, Rayleigh's correction ("Theory of Sound," vol. 1, p. 252; ed. 1894) makes the velocity a function of the mode of vibration, Poisson's ratio, and (rk/l). The work last year on the velocity of ultrasound in metallic rods of different proportions, using the method of high frequency piezo-electric excitation, indicated where the correction for lateral inertia should be applied (*Science Progress*, **89**, p. 92; July 1928). For example, with duraluminum, for $(rk/l)^2 < 0·07$, the effect of lateral inertia is inappreciable and the velocity may be computed from $V=\sqrt{E/d}$. In the range $0·07 > (rk/l)^2 < 0·3$, Rayleigh's expression gave the velocity approximately enough for most purposes; but for $(rk/l)^2 > 0·3$ the types of vibration could not be distinguished, the frequency of successive modes of any type followed no apparent law, and no known formula for velocity could correctly be applied.

Frequencies of 8000 to 200,000 cycles per second here were used with duraluminum rods of length varying from 4·1 to 61 cm. and radii of section from 0·63 to 2·55 cm.

Incidentally, the method was applied to determine Young's modulus of ice, for use in association with other problems. This physical constant is most uncertain in quoted values by other methods, but by the present method of high frequency longitudinal vibration it can be easily and quickly determined. The velocity of sound in ice just below 0° C. was found to be $3·2 \times 10^5$ cm. per second and does not vary much with changing temperature or direction in the crystal. This velocity gives a value for Young's modulus of $9·36 \times 10^{10}$ dynes per sq. cm.

R. W. BOYLE.
D. O. SPROULE.

University of Alberta,
Nov. 17.

Reproduction and Death in Invertebrates and Fishes.

IN NATURE some time ago (**115**, 155; 1925) Dr. Bidder raised again the interesting fundamental question of the cause of normal death in aquatic animals, and stated that so far as he knew there was no evidence of any marine animals dying a natural death, except those whose life is ended by the winter or the summer. Later, the same writer, after reviewing earlier discussions (*Proc. Linn. Soc.*, 1925, p. 17), argued that we have no reason to suppose that aquatic animals, such as plaice, carp, and sea anemones, ever die except by violence. It was stated that though both man and plaice, for example, increase by approximately geometrical progression in weight until the age of puberty, man after the age of twenty-eight declines in (significant) weight and must die; whereas plaice continue to grow indefinitely by positive increments, from which fact it is deduced that life in plaice—and similar animals—may be eternal. The renewal of interest in this subject is already producing practical results, and it is worth while discussing some other aspects of the problem.

The marine naturalist who sees populations of sponges, hydroids, worms, molluscs and echinoderms, and fishes, come and go, can scarcely resist the impression that the life-period is more or less proscribed in some way for each kind. The final violent effacement of soft-bodied marine animals may probably be agreed upon, but such may be only an unimportant effect of a preceding condition of moribundity; the inquiry may therefore be directed towards the possible conditions which may induce moribundity. In the first place, why do animals and other short life-period animals die? A reasonable answer is that this kind of animal dies as a result mainly of expending itself in reproduction; there may often be other contributory factors, but these may be regarded as of a second order of importance. In this type of death it would appear that the constitution of the animal is such that under certain environmental conditions the metabolism is concentrated overwhelmingly on reproduction; we may therefore define the (proximal) cause of death in such cases as the concomitance of the particular organic constitution with particular environmental conditions. (R. Pearl in "Biology of Death," 1922, expresses a similar conception.) For the sake of simplicity we may term this as death from *over-reproduction*. This fundamental conception of death—or moribundity—may be applied especially to marine invertebrates and fishes, to inquire whether reproduction may be a general predisposing cause of death in a less obvious manner than in the case of those animals whose life-period is brief.

The phenomena of death in the sponge, *Grantia compressa*, which disintegrates after becoming almost a mass of larvæ, may serve as a typical example of probable death from over-reproduction (in Child's terminology ("Senescence and Rejuvenescence," 1915) one might perhaps use the term over-senescence). Death in nudibranchs, jelly fishes, many isopods, polychætes, some shore fishes, and no doubt many other forms, may readily be interpreted in the same way. Species which exhibit this form of death are, however, adapted to their environment and survive, but are subject to great fluctuation in numbers from year to year. Other species, which do not die after the first or earlier phases of reproduction, normally pass through a recuperative stage, persisting in either a functional state, or avoiding metabolic unfitness by hibernating or æstivating, and may afterwards begin growth again. Nevertheless, the reproductive phase comes around again periodically, and it becomes necessary to know whether, later in life, reproductive activity increases at a greater rate than can ultimately be borne by the bodily increments between successive periods of reproductive activity.

It should be possible in many cases to express these two factors, for example, bodily increments, and increments in reproductive elements, in terms of weight, as Fullarton and—later—Miss Mitchell did in pioneer studies on a few fishes (Fishery Board for Scotland, 1908–1911, Cd. 6950); if it be found in this way, for example, that the acceleration in weight of the spent body eventually becomes significantly smaller than that of the spent body plus the reproductive elements, then, either death will follow from over-reproduction, as in *Grantia*, or what in practice is the same, the animal may become so unstable in its reproductive equilibrium that any accumulated sub-lethal factors along with the normal rigours in the environment—

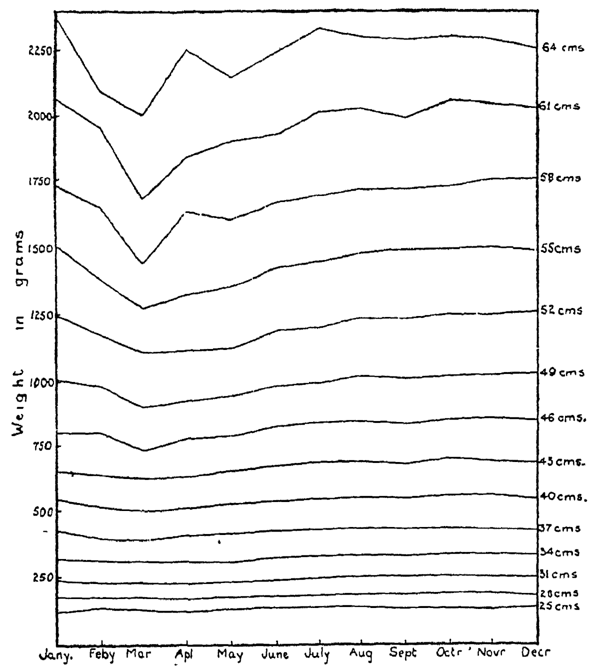

FIG 1.—Seasonal variation in weight of gutted haddock at Grimsby, 1910–11 (after E. S. Russell). Reproduced by courtesy of Dr. Russell and permission of the Controller of H.M. Stationery Office.

especially those occurring at about the time of reproduction—may cause such unfitness as, in the sea, must result in death.

The remarkable increase in amplitude in reproductive activity with age implied in Russell's observations (see Fig. 1) (Fish. Invest. II. 1; 1924) on the haddock, along with somewhat similar demonstrations in plaice by Masterman (Board of Agric. and Fish. Cd. 5686; 1911) and D'Arcy W. Thompson ("Growth and Form," Cambridge, p. 100), illustrate how reproduction may eventually overbalance normal metabolism and result in death. Russell indeed suggests that in the larger haddock the gonad probably forms a *relatively greater* proportion of the total body weight than in the smaller fish. Other fishes and invertebrate aquatic animals may be expected to provide information of a similar type, so that it may be possible when significant data are known to fix the average probable age of death in particular cases: for such epitomes of the reproductive life-history, as that of the haddock shown above, may give the rate of increase in amplitude of the pendulum of senescence to a true critical point.

In marine invertebrates and fishes there is good ground for regarding breeding as a compulsory rhythm in the healthy individual, and that as a result there is apparently no escape from the periodically increasing strain of the reproductive cycle (accumulative senescence ?). If, on the other hand, we assume that breeding ceases in marine animals at an advanced age, we are probably admitting that death will follow, for a marine animal which is incapable of breeding is already (in a restricted sense) biologically dead ; the longevity of some aquatic animals in confinement may perhaps be due to their avoidance of the reproductive strain. The rate of increase in reproductivity with age in other marine animals than fishes is a relatively unknown subject, but in many forms valuable information could easily be acquired.

From my own data (*Jour. M.B.A.*, **15**, 2 ; 1928) on the oyster there is a strong indication that the weight of sexually mature individuals up to an age of about seven years increases at a greater rate than that of sexually spent individuals (taking similar estimated ages as a criterion of similar sizes), so that the amplitude of reproductive activity may be expected to increase with age in the same way as in the haddock, and life will apparently—or perhaps must—become unstable at the weakest point in the reproductive cycle (*sic*) at about the spawning time. On the difficult subject of normal mortality there is in the oyster—as in some other forms—probably a maximum at about the spawning period. Enough has perhaps now been presented to focus attention on the probable importance of over-reproduction—along with other contributory factors—in predisposing or causing death in marine animals. A collection of figures and facts—and especially facts regarding physiological states—is now required to bear on the problem before proceeding further, and in any event, mathematical expressions of the rate of reproduction (as defined) in a variety of aquatic animals would provide information of much general interest.

J. H. ORTON.

Marine Biological Laboratory,
Plymouth, Nov. 13.

Rotation of the Earth and Magnetostriction.

IN 1926, Prof. E. W. Brown presented the evidence indicating remarkable changes in the rate of the earth's rotation (*Trans. of the Astronomical Observatory of Yale University*, vol. 3, part 6). Changes, more or less abrupt, were shown to have occurred about 1785, 1850, 1898, and 1918. Prof. Brown finds that the observational data are consistent with the hypothesis of an oscillatory change in the earth's mean radius. Why the earth should expand and contract, he makes no suggestion, but gives a study of the occurrence of earthquakes, which, however, shows no well-defined correlation. He cites a theory of Prof. Joly (*Observatory*, February, 1926) that the vertical oscillations of the earth's crust may be caused by a thermal effect of radium acting in a substratum of basalt.

Prof. W. de Sitter has discussed the relation of the earth's rotation and astronomical time in NATURE (Jan. 21, 1928, page 99). To satisfy the observations, he combines the effect of changes in the size or shape of the earth and the variable force of tidal friction. He does not explain what may expand or distort the earth.

I have taken considerable interest in the variable rotation of the earth, and recently have tried to relate it with magnetostriction. Why may not the earth pulsate under varying magnetic force ? An iron bar may be lengthened a millionth part by magnetisation even in a moderate field. In stronger fields it suffers contraction, but we are not concerned with such fields. Now the earth has an iron core at the centre, which may perhaps be expanded by increase of magnetic force. With expansion, the earth's rotation would be retarded. It might be that the increase of the earth's diameter would be in the line of the magnetic poles. However these are far enough from the axial poles to produce some effect. It may be questioned how much of the iron core, on account of its heated condition, might become magnetised. If the magnetisation is at the periphery of the iron deposits surrounding the core, that may accord with one of the calculations of Brown, in which changes in pressure are conceived as taking place in an outer stratum.

Of the measures of terrestrial magnetism, observations of the declination are in general the most trustworthy. In seeking a correlation, it seemed best to use the secular change. *Special Publication of the U.S. Coast and Geodetic Survey*, No. 126, gives the change in declination with time for places distributed over the whole of the United States at intervals of 2° of latitude or longitude. The secular change was easily derived by taking differences of the tabular values. I have plotted curves for many of these stations, using the secular change (+ to west) for 10-year intervals. Although many shifts and variations occur for different parts of the country, yet there are three striking features. A pronounced minimum occurs in the vicinity of 1900. A maximum is found near 1850 for eastern sections, and about 1890 for western sections. On many of the plots we find another maximum about 1920. It seems remarkable that these maximum or minimum points should occur so near the dates found by Brown for changes in the length of the day. I have studied also data for a few stations in Europe with similar results.

Some of these changes have been noted elsewhere. Chree ("Enc. Brit.," vol. 17, page 359) remarks: "The rate of movement of the needle to the east at London—and throughout Europe generally—fell off markedly subsequent to 1880. . . . Thus in 1902 it was at least open to doubt whether a change in the sign of the secular change were not in immediate prospect. Subsequent, however, to that date there was little further decline in the rate of secular change, and since 1905 there has been a very distinct acceleration." Discussing further, in particular concerning the anomalies of secular change in the United States, he writes : "Auspices do not all point one way, and the future is as uncertain as it is interesting." Since that time we have had the maximum which set in about 1920.

Much work has been done at various places to relate sunspots and magnetic declination. Without expecting much, I have put together sunspot data. Plotting curves of Wolf's sunspot numbers, and then connecting maximum points, the curve so drawn shows a minimum about 1905. This proves very little, as a still lower point of the curve occurs about 1804 and 1816.

It must be said concerning the hypothesis of magnetostriction producing oscillations in the earth's diameter that the force of the magnetic field of the earth is quite weak. Moreover, the interior of the earth contains not only iron but also nickel, which contracts in all magnetic fields. These are complicating factors. The correlation between the secular changes in declination and the change in the rate of the earth's rotation appears important. It may be that the changes in declination are pressure effects arising from the slight adjustments of the structure within the earth. The rearrangement of the strata sufficient to produce the changes in the length of the day, might also, by magnetostriction, affect the earth's magnetic conditions. We would then be dealing with results from a common cause.

The whole question is of great interest, and I shall pursue the inquiry further. Meanwhile, I have written this note in the hope that others, better acquainted with the magnetic and geophysical aspects of the problem, may pass their judgment.

EDWARD S. KING.
Harvard College Observatory,
Cambridge, Massachusetts,
Nov. 21.

Oxide Films responsible for the Tints on Heated Copper.

MUCH has been published on the tints of heated copper, but disagreement prevails regarding the oxide responsible for the colours; Dunn (*Proc. Roy. Soc.*, **111** [A], 211; 1926) apparently attributes them to cuprous oxide, and Constable (*Ibid.*, **115** [A], 583; 1927) to a "veneer of cupric oxide." Recently the oxide films have been isolated from their basis, the metal being dissolved from below by anodic treatment in concentrated potassium sulphate solution; the oxide films, thus undermined, peel off in curling flakes, which retain the grooves and ridges left by the abrasive treatment used to clean the copper before oxidation. The thicker films can also be removed mechanically.

The two oxides present in the films are quite different in appearance and can be distinguished by chemical tests. At thicknesses above the interference colour range, cuprous oxide films appear brown by transmitted light and exhibit by reflected light a characteristic colour best described as pale chocolate; but a veneer of cupric oxide produces a dark grey reflex without a trace of brown or red. Residual metallic copper, where it exists in the films, has a bright red lustre and is opaque; its presence may be revealed by the action of silver nitrate, which produces a microscopic 'silver tree.'

It has been found that the colours are due to cuprous oxide. Cupric oxide is indeed formed under strongly oxidising conditions, but it obscures the colours, and must be avoided if the later tints are to be obtained. Thus Constable, working under conditions favourable to the production of cupric oxide, obtained no colours beyond the middle of the second order, the tints darkening and passing into the black characteristic of cupric oxide. This has been confirmed, but it was found that if the formation of cupric oxide is avoided, the sequence can be followed to the fourth order; the tints then pass gradually into the characteristic colour of cuprous oxide. The easiest way to prevent the formation of cupric oxide is to use a *mildly* oxidising gas mixture—preferably obtained from a flame of pure alcohol.

Within the interference-colour range, the cuprous oxide films are quite transparent. On the whole, the oxide film taken from copper tinted to an early colour is more transparent than that taken from copper displaying a high-order tint; but in the latter case fragments of thin, highly transparent films are also separated along with the thicker skin. This is apparently due to the fact that the skin cracks as it thickens, allowing air access to the metal exposed at the crack, so that another film is formed below the first; this lower film will be generally thinner than the first and will diminish in thickness with the distance from the crack. The formation (at a crack) of one skin below another has been directly observed at high temperatures, and there is evidence that the phenomenon is general; for it is found that copper heated rather too strongly for interference colours nevertheless yields—on stripping—flakes which display bright colours, the tints varying from place to place as the result of varying thickness.

The colours of the stripped films are often brilliant by reflected light, rose, blue, and green hues being obtained; by transmitted light the interference tints are largely masked by the yellow hue due to selective absorption, but there is a slight variation of colour with thickness between yellowish-green, bright yellow, and brown.

The films isolated from copper tinted to the early first-order colours usually contain opaque spots due to included metallic copper, and the metallic residue increases on passing to films taken from copper heated insufficiently to produce colours. In films removed from copper merely exposed (after abrasion) to dry air at *ordinary temperatures*, the opaque areas generally predominate over the transparent areas, although the character of the composite oxide-metal layer varies with the nature of the abrasive treatment employed. The composite layer appears to be formed as follows: Abrasion produces a network of cracks, increasing the true surface area, as found by Bowden (NATURE, **112**, 647; 1928). On exposure to air, the walls of these cracks become oxidised, and the internal oxide-sheaths obstruct to a large extent the anodic removal of metallic copper, so that the layer left (after the unchanged basis has been dissolved away) consists of both metal and oxide. Clearly with increasing temperature or time of exposure to oxygen, the proportion of residual metal in the layer stripped will diminish, and hence the films obtained from copper tinted to any of the later colours are practically free from metal.

ULICK R. EVANS.
University Chemical Laboratory,
Cambridge.

Radio Echoes and Conditions for their Occurrence.

SINCE October 24, the emission of signals (see NATURE, Nov. 3 and Dec. 8, 1928) from the short-wave emitter PCJJ (Holland) has been continued twice a week, and sometimes more frequently. Through the Norwegian Telegraph Office a series of receiving stations has maintained a continual watch, and an oscillograph has been ready for use at all times, but no echoes have been heard, either in Norway or in Eindhoven.

It appears from this, and from the long silence during experiments in the spring and summer, that the echoes constitute a very rare phenomenon and owe their occurrence to a series of favourable coincident circumstances. The wave-length must be the most favourable one, and the emission must be sent out in the right direction and with sufficiently great energy. (A transmitter station in the tropics would probably be better than a station in Holland.) The Kennelly-Heaviside layer must be penetrable by the outgoing and returning waves, and must also be favourable for the hearing of both signals and echoes, and the receiving apparatus must be sufficiently sensitive and exactly adjusted.

Further, there must be good conditions for hearing without too many atmospheric disturbances, and, last but not least, the emission of electrons from the sun must take place in such a way that reflecting surfaces in space outside the orbit of the moon may be formed and may have the most favourable shape for a good reflection of the waves.

As regards the last point, the mathematical theory of the motion of electric corpuscles around a magnetised sphere shows that the chances of obtaining a well-defined toroidal space round the earth are good when the direction to the sun lies near the magnetic equatorial plane (perpendicular to the magnetic axis).

This result is in close agreement with a remarkable experiment made by the late Prof. Birkeland [1] which is reproduced in Fig. 1.

Here cathode rays are sent from an aluminium plate near the magnetic equatorial plane of the magnetic sphere, and a part of the toroidal space is very well seen with corners of rays descending to the polar regions of the sphere, corresponding to the

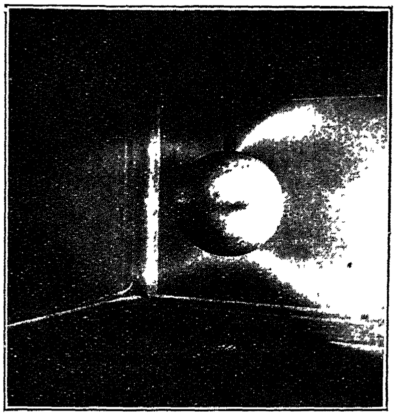

Fig 1 —Cathode rays in relation to a magnetised sphere.

production of polar auroræ. On the two occasions, Oct. 11 and 24, when echoes were heard, the sun was not far from the earth's magnetic equatorial plane. But such favourable occasions disappeared towards the end of October and will not recur before the middle of February. Thus, if this explanation of the most favourable situation of the sun is correct, it is improbable that echoes will be heard again before that time.

Carl Størmer.

Oslo, Dec. 12.

[1] See "The Norwegian Aurora Polaris Expedition, 1902–1903," vol 1, Second Section, Fig. 265a, p. 712 (Longmans, Green and Co., London.)

Soap Film Pressure Gauge.

If a soap film is formed across a circular aperture in one side of an otherwise closed box, and if then air is introduced into, or removed from, the interior, the surface of the film becomes part of a sphere, and therefore the pressure within the box differs from that outside by a quantity which is directly proportional to the surface tension of the film, and inversely proportional to the radius of the sphere.

If R, r, and T are respectively the radius of the hole, the radius of the sphere, and the constant of surface tension, the difference of the air pressure inside and outside the box is $4T/r$ (since both surfaces of the film contribute to the tension) and the difference is + or − according as to whether air has been introduced or withdrawn.

The radius of the sphere can never be less than R. and when $r=R$ the surface of the film is a hemisphere. Thus $\pm 4T/R$ is the greatest difference of pressure which can be balanced by the surface tension.

For any condition which makes the bubble less than a hemisphere, the film may be used as a pressure gauge, since the difference of pressure within and without the box can be determined if T is known and r measured. There are several ways by which the radius of a bubble can be found, that which I have generally used being to measure the size of the virtual image, reflected by the film, of an object of known size and distance. This allows of the determination of r with considerable accuracy.

Convenient apparatus for the purpose can take many forms which need not be described here, but it is worth while to note the order of pressure difference which can be measured by soap films as compared with various other forms of barometric measurement. A good barometer or aneroid will indicate the difference of level between the surface of the table and the floor on which it stands, say a head of 30 inches of air. For a soap film, suppose, for example, that T has a value of 3 grains per linear inch and that $R=1$ inch, then the maximum pressure difference which can be sustained by surface tension is 12 grains per square inch—equivalent to a head of about 3 feet of air. Thus for this particular case the greatest pressure difference which can be dealt with by the soap film is not far from the minimum which can be observed by the aneroid. With a soap bubble, however, the radius can without much trouble be determined with sufficient accuracy to allow of the measurement of pressure difference equivalent to heads of a few hundredths of an inch of air.

I used this form of pressure gauge to find out whether, when a chimney smoked, the pressure in the room rose or fell. A rise of pressure would show that the wind blew down the chimney, and a fall that there was negative pressure on the lee side of the house. In stormy weather I found many instances of both kinds, and the type which prevailed depended, as might be expected, on the direction of the wind.

A. Mallock.

9 Baring Crescent, Exeter.

Delayed Metamorphosis in a Predaceous Mosquito Larva and a Possible Practical Application.

On June 10 of this year, in a rot-hole in a tree at Epe in Southern Nigeria, I secured a young specimen of the predaceous larva of the mosquito *Megarhinus* (*Toxorhynchites*) *brevipalpis*, Theo. With the intention of bringing the insect alive to England, it was retained in two or three ounces of its natural water and given a very restricted diet in the form of an occasional *Stegomyia* larva.

It was eventually brought to England in the middle of August, and was maintained at 24° C. without any special attention, until it died on Nov. 18 without having passed the larval stage.

My reason for recording these observations is that it has been suggested (Buxton and Hopkins: "Researches in Polynesia and Melanesia"; London, 1927) that members of this predaceous genus of mosquito, which breed exclusively in rot-holes, should be introduced into Fiji, Samoa, and other South Pacific islands as a measure of control of the local vector of filariasis (*Aedes* (*Stegomyia*) *variegatus*) which breeds in the same situation. The nearest locality for *Megarhinus* in that part of the world is, however, the Bismarck Archipelago, and the difficulty and expense of establishing (as has been deemed necessary) intermediate stations in the conveyance of the insect from New Guinea to Queensland and thence to Fiji and Samoa—a distance of some 3000 miles—has prevented any attempt at the experiment.

It now appears from the observation recorded above that by simply limiting the food supply the larval stage of this insect can be prolonged by at least five months, which would afford ample time for the transmission of larvæ direct, and thereby greatly facilitate the carrying out of the experiment in question.

V. B. Wigglesworth.

Department of Medical Entomology,
London School of Hygiene and
Tropical Medicine.

Nitrogen Fixation: the Growth of a New British Industry.

THERE have always been those who delight in prophesying catastrophes to the human race, just as there have always been those who do not listen to them. The future of mankind may, indeed, be violently affected by some unexpected and extremely disconcerting cosmic disturbance; it is certain to be influenced in a less spectacular although equally impressive manner by limitations in the natural productivity of the earth's surface, and in the extent of the remaining reserve areas of virgin soil. In a mere comparison of rates of productivity we appear to have ample material wherewith those so minded can, without much risk of contradiction, anticipate a first-class human disaster; we also have an indication that the so-called 'nitrogen problem' is not a transient condition, but a situation which in our own day needs courageous, systematic, and world-wide measures for its solution. We may assume that between a date which remains controversial and A.D. 1800 (perhaps half a million years, perhaps more) the population of this earth reached 800 millions of human beings, whilst from A.D. 1800 to 1900 it rose to 1730 millions; if this rate of increase continues—and there is no reason to anticipate the contrary—an early intersection of the population curve and the soil productivity curve is necessarily to be expected. Indeed, it has been estimated that the present methods of farming will lead to a definite food scarcity before the end of the present century.

However unpleasant an episode in the history of our race such an intersection might indicate, it would be more profitable to consider, while there is yet food enough and to spare and while any inadequacy of clothing is due to causes other than lack of raw materials, the alternative policies which are open to us. We may be compelled to find a means of restricting the rate of increase of the population, or we may submit to restriction by starvation; we may even discover forms of food which are not agricultural in origin. The obvious line of advance is, however, to seek to increase substantially the average output of the soil under cultivation. This course involves not only a development of improved methods of farming, but also a cheaper and more abundant supply of inorganic fertilisers—particularly of suitable compounds of nitrogen.

Both of these matters are major problems with which the intelligent world finds itself confronted, and both are of dimensions which are scarcely amenable to parochial, even strictly national, treatment. In the course of their development, for example, the primitive methods of cultivation in Eastern countries will gradually be replaced by more modern methods, in which the liberal, but always scientifically controlled, application of fertilisers not originating from previous agricultural operations will play their part in safeguarding the world's food supply and raising the standard of living. It has been computed that in pursuance of this policy an annual addition of 125,000 tons of fixed nitrogen, that is, nitrogen in the form of suitable compounds, to the world's productive capacity is immediately necessary, and that in the future the amount will need to be larger.

The nitrogen in the atmosphere cannot in general be assimilated by plants, although certain classes, particularly leguminous plants, are able with the assistance of appropriate bacteria associated with their roots to draw upon this enormous reserve of nitrogen, and thereby, in fact, to enrich the soil. It will be remembered that in 1852, Lawes and Gilbert showed that non-leguminous plants require for their growth a supply of nitrogenous compounds, and that the ammonia in the air, supposed by Liebig to be the source of the necessary nitrogen, was insufficient for the purpose; the stages in the investigations leading to Hellriegel and Wilfarth's discovery of the effect of bacterial action in the assimilation of atmospheric nitrogen by leguminous plants form a chapter of considerable interest. Rothamsted, the home of Lawes and Gilbert's, and of a continuous succession of similar, experiments enjoys the distinction of laying a not inconsiderable part of the foundations of scientific farming and of the nitrogen industry, not only in Great Britain, but also throughout the world.

In his address to the British Association in 1898, Sir William Crookes said: "The fixation of atmospheric nitrogen is one of the great discoveries awaiting the ingenuity of chemists. It is certainly deeply important in its practical bearings on the future welfare and happiness of the civilised races of mankind." Before 1914 the world's requirements of nitrate-nitrogen were supplied from Chile, where immense deposits of sodium nitrate (associated with a small proportion of iodine in combination) were discovered only a hundred years ago. Apart from similar nitre beds in Peru and Bolivia, all rainless districts, no other extensive deposits are known or anticipated to exist. Exportation from Chile commenced about 1830, and by 1912 had reached more than two and a half million tons, representing 57·5 per cent of the total world's output of fixed nitrogen; 38 per cent was accounted for as by-product ammonium sulphate, originating from the illuminating gas and metallurgical coke industries. Various estimates have been made of the probable life of the South American deposits; apart from considerations of economics, it is probable that they would be able to supply requirements for at least a century—a 'breathing space' but not a very long period in the normal life of an animal species.

The agricultural prosperity of the British Empire has therefore been to an appreciable extent dependent on the goods exported by another nation, and this subjection the British chemical industry has the power, and the intention, to neutralise. The existence of the British Empire was, not very long ago, dependent on its opportunity to purchase nitrate from Chile and its ability to transport the material to our own ports. This three-fold dependence is one which, it is to be

hoped, will never again exist. The intention in this article is not to dwell on the place of the nitrogen industry in the defence of the British Empire, but it would be an affectation to ignore the undisputed fact that that position is vital. God forbid that it should ever again be necessary for Great Britain to defend her shores with arms, but only while she can fix her own nitrogen has she the certainty of possessing the raw materials for her munitions. So crucial, indeed, is the supply of fixed nitrogen in such an emergency, that voices have been raised against allowing the British industry to be under any control but that of the State; on the other hand, the record of State fixation of nitrogen in Great Britain is not such as to lend undue support to the contention.

The methods which have been employed in solving what is commonly known as the 'nitrogen problem' are familiar. Apart from the striking development of natural supplies already mentioned—supplies of by-product ammonia being stationary, or even on the decline—methods based on the union of atmospheric nitrogen with oxygen or with hydrogen, either directly or indirectly, have been worked out on a laboratory scale, applied to a technical process, and have met with considerable, although naturally fluctuating, economic success. The three most important processes are:

(*a*) The arc process, in which nitrogen and oxygen are exposed to the very high temperature of an electric arc, whereby 1·15 per cent of nitric oxide is formed, this gas then being oxidised by air to nitrogen dioxide, which by reaction with water or alkaline liquids yields nitric acid, nitrites, and nitrates. This process is losing ground on account of the high production costs and power requirements, and is manifestly unsuited for use in Great Britain, where cheap electrical energy is not available; in Norway, however, and elsewhere, it continues to be employed. It has the advantage of employing free materials and a small amount of labour, and of producing nitric acid directly; on the other hand, the installation costs are high, and nitric acid is not a convenient product for transportation and agricultural use. For this purpose calcium and ammonium nitrates are manufactured. The credit of invention of the process, or rather of the successful technical adaptation of Lord Rayleigh's method for combining nitrogen with oxygen, belongs to Prof. Birkeland of Christiania, and Dr. Eyde, a Norwegian engineer; subsequent developments in furnace construction are associated with the names of Schönherr and of Pauling.

(*b*) The cyanamide process, in which impure calcium carbide is exposed at a high temperature to the action of nitrogen, producing calcium cyanamide, $CaCN_2$, which when subjected to hydrolysis in an autoclave affords ammonia. This process has been in use at Niagara since 1909, and is a familiar process elsewhere; it was the process chosen for use at the great war factory erected at Muscle Shoals, Alabama—a factory which cost twenty million pounds but never came into production. Here again Great Britain suffers from the disadvantage of the high cost of electrical energy necessary for producing the carbide from lime and coke, and for heating it in contact with nitrogen; admittedly Great Britain (except in the Scottish Highlands) lacks adequate water power, but she has been slow to harness such natural power as is available.

(*c*) Haber's catalytic process, in which a mixture of hydrogen and nitrogen under pressure is heated to a moderate temperature in chrome-steel bombs in the presence of a suitable catalyst, such as pure iron mixed with small quantities of alkalis and acidic oxides, the ammonia so formed being removed by dissolution in water. This process makes no extravagant power demands, and is suitable for development in Great Britain; for reasons which will appear later, it is, nevertheless, associated with technical difficulties of no mean order. The hydrogen can be produced by the electrolysis of water, by the action of iron on steam, from water-gas, or in the fermentation process for the production of acetone and butyl alcohol; the nitrogen can be obtained by fractionation of liquid air. In the Bosch process the mixture of nitrogen and hydrogen is obtained from producer gas and water gas. The famous German factories at Oppau and at Merseburg are devoted to the direct synthesis of ammonia. Claude's modification of the process employs pressures of the order of 1000 atmospheres, and removes the ammonia by liquefaction.

These three methods, as has been explained, form the backbone of nitrogen fixation as a technical operation subject to economic considerations. Any process which produces ammonia is naturally to be combined with an oxidation process if—as is the case when munitions of war or intermediates for the chemical industries are concerned—it is desired to manufacture nitric acid. This is accomplished by a catalytic method, generally known as Ostwald's method, in which a mixture of gaseous ammonia with air or oxygen is passed over heated platinum, whereby nitric oxide, afterwards oxidised by the further action of air or oxygen to nitrogen dioxide, is obtained. On dissolution in water under oxidising conditions, this gas affords nitric acid. Numerous variations in the arrangement of the catalytic converter have been worked out and employed in Great Britain and elsewhere. Incidentally, it has been found that the catalytic oxidation process can be profitably applied to the production of nitrogen oxides in the lead chamber process for manufacturing sulphuric acid; indeed a British report on the subject was issued so early as 1917.

Passing reference may also be made to other and less successful processes for the fixation of nitrogen. The Serpek process is based on the production of aluminium nitride when nitrogen is passed over a mixture of carbon and impure aluminium oxide; the reaction may be carried out under pressure. On hydrolysis of the product with sodium hydroxide solution in an autoclave, ammonia and sodium aluminate solution result, the latter affording pure alumina (suitable for the manufacture of aluminium) on treatment with carbon dioxide. In Bucher's process, nitrogen is passed through a mixture of sodium carbonate and carbon, together

with a little finely divided iron as catalyst, heated at about 950°, when sodium cyanide and carbon monoxide are produced; the sodium cyanide is then decomposed by steam yielding sodium formate and ammonia. Partington and Parker ("The Nitrogen Industry," 1922) state that the United States Government made careful investigations of this process, and that a large plant was said to be ready to begin operations in 1918.

However, the direct catalytic synthesis of ammonia is probably to be regarded as providing the key to the world problem of nitrogen supplies. The atmosphere contains enough—some 4×10^{15} tons, it is said—and to spare; Haber's process makes no excessive demands as regards power or fuel, and it now holds a pre-eminent position in the field of nitrogen fixation. In view of its proved success and its established position in Germany under conditions both of war and of peace—manufacture there having been proceeding since 1913, and production in Germany to-day being of the order of 600,000 tons per annum of nitrogen—it is not surprising that in the development of the nitrogen fixation industry, which continues to extend rapidly in most European countries, as well as in the United States of America and in Japan, new plants should envisage the application of this process almost exclusively. The advantages which direct synthesis of ammonia offers are, in fact, such as to introduce the method into Norway, the home of the arc process.

(*To be continued.*)

The Skull of Lord Darnley.[1]

IN the year 1869 Mr. J. W. Belt presented to the Royal College of Surgeons a skull—minus a mandible—and a thigh bone, believed by the donor to be those of Lord Darnley. He had obtained them from Mr. Grimshaw, a dealer, who had bought them four years earlier at a sale by Messrs. Sotheby and Co. of certain effects belonging to the Hon. Archibald Fraser of Lovat. The Conservator of the Museum, looking the gift horse in the mouth, entered the bones in the Museum catalogue, with the remark that "the internal evidence afforded by both bones conclusively negatives their authenticity. Darnley at the time of his death in 1567 was about 22 years old, and the bones are those of a man considerably more advanced in life and of great muscular development. The almost complete absence of frontal elevation, which is one of the most striking features in the skull, finds no corroboration in any of the known portraits and descriptions of the young Earl, and the femur could not be that of a person invariably described as 'tall' or 'long,' as calculating at the usual ratio of 27·5 to 100 it would give a height of only 5 feet 2·2 inches." So adverse a decision would be sufficient to deter most from further inquiry, but not Prof. Karl Pearson, who has attempted, with what success we shall see, to establish the authenticity of the more important of the relics, namely, the skull.

In 1880 Mr. T. M. Grimshaw—presumably the same man from whom Mr. Belt obtained the bones mentioned above—offered the Conservator of the Museum of the Royal College of Surgeons a femur bearing a manuscript label to the effect that it was "the thigh bone of Lord Darnley, husband of Mary Queen of Scots, murdered and blown up, February 10th, 1567." This, he stated, had been bought at a sale at Sotheby and Wilkinson's, together with two other bones, "the thigh bone of Little John, the companion of Robin Hood, and the shin bone of Humphrey, Duke of Gloster"; no mention is given of the date of this sale. The femur was purchased and entered in the Museum catalogue as "that of a very tall man, probably the real thigh bone belonging to the skull," presented eleven years earlier by Mr. Belt, an assumption which is almost certainly correct, for skull and femur exhibit the same peculiar coloration, "such as usually obtains," to quote the new catalogue, "in bones that have lain long in a peat bed."

If we accept, as we think we safely may, the single origin of the two relics, namely, the skull presented in 1869, and the femur purchased in 1880, then clearly, from the point of view of authenticity, they must stand or fall together. The authenticity of the femur gains support from the manuscript label, but suffers from the strange company in which the bone appears, company for which Prof. Pearson has no use, dismissing them summarily as "bones of most absurd attribution." In this we think Prof. Pearson has done wrong, for a little inquiry would have shown that the bones might very well be those of the more or less venerable Englishmen to whom they were ascribed. 'Little John'—or such part of him as was not apocryphal—was a big, stalwart man, whose grave is still to be seen in Hathersage churchyard. The grave was rifled, we are told, in 1782, and again in the early years of last century, when a thigh bone, measuring, it is said, 32 inches, was taken from it.[2]

Humphrey, Duke of Gloucester, murdered at Bury St. Edmunds, was buried in St. Albans Cathedral. The leaden coffin containing his body, and "full of pickle," was opened in the reign of Queen Anne; the body was taken out of the preserving fluid, and "reduced to a skeleton, the smaller bones of which the vergers permitted visitors, for a due consideration, to carry away."[3] If, then, the two bones can scarcely be described as Daniels come to judgment, they are nevertheless not the guys which at first sight they appeared. They further serve the useful purpose of restoring our confidence in the good faith of Sotheby and Grimshaw, a not unimportant matter, seeing that they are among the sponsors for the relics. Sir Arthur Keith[4] thinks it "most probable" that

[1] *Biometrika: a Journal for the Statistical Study of Biological Problems.* Edited by Karl Pearson, assisted by Egon S. Pearson. Vol. 20 B, Part 1, July. Pp. 104+46 plates. (London: Biometric Laboratory, University College, 1928.) 21*s.* 6*d.* net.

[2] "Guide to Buxton, the Peak, Dovedale, etc." (London: Ward, Lock and Co.)

[3] "Saint Albans" (Bell's Cathedral Series).

[4] *British Medical Journal,* Sept. 8, 1928.

the femur presented by Mr. Belt with Darnley's skull was the femur of 'Little John.' This can scarcely be, but, granted a certain confusion, and such appears to have occurred, and was not unlikely in a saleroom, where such objects as bones can be so easily mislaid, forgotten, and wrongly ascribed, it is not impossible that the femur in question is that of Humphrey, a man of no little importance in his day, own brother as he was of Harry of England.

It is now time to record certain strange events which followed on the death of Darnley. His body, blown up by the explosion at Kirk o' Field on the morning of Feb. 10, 1567, was bowelled and embalmed with perfumes and spices, and four days later buried in the Royal Vault in the south-east corner of the Abbey Church at Holyrood. There the body lay in undisturbed privacy until January 1683, when, in the removal of certain seats, the Royal Vault was discovered and found to contain six leaden coffins. Of these, two contained the bodies of children, the infant sons of James V.; three bore on them, or near them, inscriptions indicating that they contained the bodies of James V., his first Queen, Magdalen, and his illegitimate daughter, the Countess of Argyll. James's body was coloured black with the balsam which preserved it, which was like melted pitch. The sixth and largest coffin contained a body not so long as that of James V., with the muscles of the thigh seemingly entire, and with balsam stagnating in some quantity at the foot of the coffin: it bore no inscription, but it was generally and confidently supposed to be that of Lord Darnley.

In 1688 the 'Glencairn purging' included the violation of the Royal Vault, but apparently the bodies were left more or less intact, for in 1735—incredible though it seems—they were seen "lying open to the view," the coffins having been broken into by the mob in 1688. Still later, in 1776, they were seen by Arnot, "the head of Queen Magdalen being entire and even beautiful." In 1778 the same antiquary reports that both the Queen's head and Darnley's skull had vanished. It will be noticed that references are to Darnley's skull, not to his head, from which we may presume that the embalming, always "an hazardable piece of art," had not been so successful in his case as in that of Queen Magdalen. No mention is made of the colour of his skull, but it seems not unreasonable to assume that it was like that of James V., black.

We next hear of the skull through Alexander Campbell, who wrote that it "is preserved among the curiosities of the Antiquarian Society of Scotland, exhibiting melancholy proof of the effects of his incontinence"—a significant remark, for it implies that some part or parts of the skull had been eaten away, the popular and not unscientific conception of the effects of syphilis, and further explains the relative ease and confidence with which the relic was followed in its subsequent wanderings. In spite of Campbell's statement, no mention of the skull has been found in any of the catalogues of the Scottish Society of Antiquarians, an omission attributed with some reason to its being the personal property of James Cummyng, the secretary of the Society, who would naturally hesitate to make it publicly known that he was in possession of so important a relic, obviously nefariously acquired. At his death it is believed it was sold by his executors with other of his effects, passed into the hands of an Edinburgh sculptor, and finally into those of Archibald Fraser of Lovat. No mention, it will be noted, is made of the thigh bone until it appeared with the skull in Sotheby's catalogue.

Such, then, is the historical evidence—not, it is true, absolutely convincing, and yet not, we think, to be lightly set aside in view of the general and confident identification of the body in the large coffin, of the early recognition of distinctive marks on the skull, and of the reputation of the various witnesses. The chain of evidence is complete, but not all the links are strong.

We now pass to a consideration of the actual relics, for confirmatory or rebutting evidence. First, as regards their colour: this varies from a light brown to a blue-black. Dr. H. A. Harris, in a recent article,[5] attributes both the colour and the polish, here and there apparent, to the bones having been painted with shellac. Prof. Pearson attributes them to the body having been embalmed, to the "stagnating balsam" to which reference has already been made. The question cannot, we infer, be decided by the chemist, as both shellac and balsam are resinous substances. Of the two explanations, we are inclined to accept that of Prof. Pearson. The extreme variations in colour, thickness, polish,—the patchy distribution are all against the coating being due to the undiscriminating 'dead' hand of man working with a uniform medium, and in favour of the more or less natural 'wash' of a solution of varying composition, picking out for different treatment different anatomical areas. We would particularly instance the appearance of the posterior surface of the neck of the femur, there being a sharp distinction between the colour and patina of the upper and lower parts, the line of separation agreeing exactly with the line of attachment of the capsule of the joint. It is difficult, again, to explain on Dr. Harris's hypothesis why the interior of the cranium is similarly coloured to the exterior.

If, then, we are inclined to accept Prof. Pearson's explanation, we might hope to find some evidence of embalming, in clinging remains of soft tissues: these we find in the interior of the cranium, for not only is part of the general dura mater still evident, but we can actually see on the left side of the mid-line the lacunæ laterales stretching from frontal to occipital region—a piece of evidence not available to Prof. Pearson when he wrote his monograph, for at that time the skull had not been opened. That the skull was never buried in the usual way is almost certain. Sir Arthur Keith has shown that there is an entire absence of earth in any of the natural cavities, such as the cranial cavity, external auditory meatus, tympanum, sphenoidal sinus. It may, however, be argued that

[5] *British Medical Journal*, Sept. 15, 1928.

the skull was that of a criminal whose body had been handed over to an anatomical department. This might be so, but in such case we should expect the calvaria to have been removed, and the bones, if kept, completely macerated. The evidence for the belief that the skull and femur are from an embalmed body is, in our opinion, strong. The description of the appearance of the body of James V., and the statement that Humphrey's coffin was full of pickle, will convey some idea as to what the results of embalming in certain circumstances might be.

We now come to the strangest of all the features of the skull, the presence of a large number of more or less circular pits on the vault—" the melancholy proof of the effects of his incontinence," to quote again Alexander Campbell. These, by many, if not by most, have been attributed to syphilis, and Prof. Pearson is at great pains to prove that Darnley suffered from this complaint, which, presumably, had reached the tertiary stage at the time of his death. We do not propose to enter into the arguments for this opinion, for we are convinced that the pits are not due to disease, the complete absence of all signs of inflammatory reaction, as both Dr. Harris and Sir Arthur Keith have pointed out, definitely negativing such a theory. If, then, as Prof. Pearson asks, they are not due to syphilis, to what are they due ? Dr. Harris confidently dismisses them as artefacts made with some such instrument as a bradawl. He gives no reason for so singular a procedure on the part of an 'unknown,' but no doubt the idea of faking evidence might be advanced. Dr. Harris's theory leaves unexplained the inequality in the size of the pits, the singular manner in which they are grouped, and their confinement to, practically, one side.

Our own theory of the pits is that they are due to the action of some burrowing insect. We arrive at this partly because, excluding the two theories already mentioned, little else remains, partly because it is well known that an extensive fauna preys upon the bodies of the dead, but mainly because of certain positive reasons. A close scrutiny of the pits will show that their circumferences not infrequently intersect, that the pits often occur in pairs, that at times part of the circumference shelves, giving a pyriform outline to the pit, at times a shallow groove leads from one pit to another, producing a dumb-bell appearance. Such features are, we consider, in keeping with what we know of the action of burrowing larvæ, which, when they meet anything uncongenial, are in the habit of moving a little aside and then proceed to burrow afresh. The varying size and shape, the number, arrangement, and distribution of the pits, all lend support to such an explanation. Can we obtain any corroboration ?

Sir Arthur Keith, when in Glasgow lately, observed certain skulls somewhat similarly pitted : two of these have now been lent by Prof. Bryce to the Royal College of Surgeons, where we have had an opportunity of examining them. They are from a medieval graveyard at Crosschurch, Peebles. Although the pits on these skulls are not so numerous or so cleanly cut as those on the 'Darnley' skull, they are, in our opinion, essentially of the same character. Further, near a pit on one of the skulls we have noticed a collection of what appears to be bone debris and earth, stuck to the skull possibly through admixture with some animal excretion, reminding us forcibly of the description by Prof. Elliot Smith of the collections left by beetles on Egyptian skulls.[6] Prof. Elliot Smith, however, is insistent on the fact that beetles only attack skulls which have been buried, a restriction with which of course the Crosschurch skulls conform, but not, if we are correct in our 'embalming' theory, Darnley's. Our ignorance, however, of the conditions within the large lead coffin both before and after the contents were exposed is such as to prevent us from offering any opinion as to whether they were more or less favourable to insect life. The pits do not appear to us to have any significant bearing on the question of the authenticity of the skull.

We have now to consider the form of the bones, and finally the age of the individual to whom they belonged. The femur clearly is that of a tall, spare individual of no marked muscular development. We are fortunate in knowing what Darnley's legs were like, for we have an admirable full-length portrait of him, aged seventeen, in doublet and hose, by Hans Eworth. Although, admittedly, there is little individuality in legs, those of the portrait are exactly those which we should expect the owner of the 'Darnley' femur to possess.

As to the skull, we fail to find those signs of great muscular development to which the Conservator of the Royal College of Surgeons in 1867—Sir William Flower—refers. We venture to think that if the skull were macerated and bleached, it would in a large measure lose such indications of muscular development as it may be thought to show. The outstanding feature of the skull is, however, as Sir William Flower pointed out, the absence of frontal elevation. Of this, it will be remembered, he found no corroboration in any of Darnley's portraits ; on the other hand, we find no certain refutation. In considering this question we must remember that portraits in early life are misleading, for then the skull is naturally of a different shape from that which it ultimately attains, and in no region, unless it be in that of the jaws, is the difference greater than in the frontal region. All the portraits on canvas which we possess of Darnley are full-face, and hence any absence of frontal elevation is, or may be, relatively unapparent. The so-called Cenotaph portrait was painted some time after death, and is, for reasons which Prof. Pearson makes plain, entirely untrustworthy. There are, however, two portraits on medals commemorating the marriage of Darnley and Mary—a third is apparently a copy of one of the others—which show Darnley in profile. They are too crude to justify any confident expression of opinion, but they go some way towards corroborating the authenticity of the skull. By the use of Coradi's

[6] *Lancet*, 1908.

pantograph, Prof. Pearson has superimposed skull on portrait, and brought out still more clearly the resemblance. We agree, too, with Prof. Pearson in finding more than a hint of a low, retreating forehead in the important full-face portrait belonging to the Duke of Devonshire, masked though it be by 'cap and hair.' On the whole, we consider the evidence of the portraits not antagonistic to the claim of authenticity.

We now come to the most critical of all the questions, for clearly, if it can be definitely shown that the bones are not compatible with their being those of a man of Darnley's age, $21\frac{2}{12}$ years, then the whole of the argument falls to the ground. To answer such a question we naturally turn to the epiphyseal lines of the femur, the spheno-occipital joint, the sutures of the cranium, and to the teeth —although all these last are missing, the empty sockets are available. We may say at once that an examination of these parts by the unaided eye gives no justification for denying the authenticity of the bones. Dr. Harris, who has paid much attention to these matters, studying them, moreover, with the aid of X-rays, thinks otherwise, and puts the age of the individual to whom the bones belonged at not less than twenty-five. He confirms his view by reference to the size of the diploic veins. Even if we accept, as with certain reservations we are disposed to do, Dr. Harris's generalisations, we would point out that the range of variation in all departments of human anatomy is wide, and nowhere perhaps wider than in such matters as those under consideration, and that in these circumstances we must allow a corresponding latitude in judgment. Nor, we would add, are the results of X-ray photography as a rule only open to one reading and interpretation.

A review of the evidence, historical and anatomical, leaves us no option, we think, but to conclude that, while certainty is denied, there is very strong probability that the relics considered, once formed part of that young, proud prince who caught the eye and won—if only for a season—the heart of perhaps the most romantic figure of modern times —" red star of boyhood's fiery thought."

Although this is neither the time nor the place to enter into considerations of Mary's character and of the part she played in Darnley's murder, we cannot conclude without paying high tribute to the learning and eloquence of the latest of her apologists. We remain, however, unconvinced. "Has he shown," as David Hume was in the habit of asking, "that she didn't marry Bothwell?" Alternatively, what of Chastelard? It was her participation, active or passive, in the two tragedies of Darnley and Chastelard, which more than all else was responsible for the bitter and almost universal hatred of two great nations, neither notably lacking in generosity and sentiment, and which drove her, a fugitive queen, to seek refuge in a foreign land.

WILLIAM WRIGHT.

News and Views.

IN continuation of a practice that NATURE has pursued for the past four years, there is printed elsewhere in this issue the first instalment of a new calendar, which will be devoted to items of importance and interest from the records of British and other patents for inventions. No apology is needed to our readers for the choice of this subject, for it will be fully realised that the literature of patents (which now includes amongst a mass of other material upwards of four million separate specifications of inventions from all countries) forms a survey of the industrial progress of the world from the seventeenth century onwards that stands unrivalled. Not much of this literature, of course, is concerned with epoch-marking inventions, but a great deal of it refers to lesser-known patents which have had no little influence on subsequent developments. Some of these have made their contribution direct, whilst others, though not themselves put into practical use, have yet stimulated later inventors, and have often formed the basis on which the final success has been achieved; others, again, have had their day and (perhaps only for a time) have passed into oblivion. It is with this class rather than with the well-known inventions that the calendar is intended mainly to deal, whilst it is felt also that a few notes should be included on some of those fruitless and extravagant ideas that are scattered through the records and have resulted in nothing but the shattering of life-long ambitions. Of necessity, the bulk of the material will be taken from British records, since these cover a longer period of time than any others, and are for the most part more easily accessible; but foreign dates of interest will also be included from time to time.

No part of Africa suffered more from the War than the Mandated Territory of Tanganyika, which comprises most of what was formerly German East Africa. From practically the beginning to the end it was a scene of conflict, with consequent breakdown of the administrative services, dislocation of its communications, interference with the normal occupations of the native inhabitants and the destruction of lives, their villages, crops, and domestic livestock. The task of repairing the havoc had to be undertaken by British officials who replaced the deported Germans. Most of these British officials were unfamiliar with the country and its peoples. They deserve the greatest credit, therefore, for the way they have coped with the difficulties of their situation. Their success can best be measured in terms of the trade of the country. The present exports and imports show a marked increase on those of pre-War years. New varieties of crops have been introduced, and the cattle industry is in a flourishing condition. The education and other social services have been greatly extended. Hundreds of miles of new railways have been constructed.

IN September next, under the presidency of the governor, Sir Donald Cameron, Tanganyika is to hold its first Agricultural and Industrial Exhibition,

which is intended to be representative of the varied agricultural products grown by the native and European farmers, of the cattle industry, the country's forest resources, and its mineral wealth—the development of which is still in its infancy. At the same time, it is expected that machinery manufacturers will instal actual working exhibits of the plant and machinery used in the cultivation and preparation of such crops as sisal, cotton, coffee, oil seeds, tobacco, tea, rice, and other grains. It is hoped that the exhibition will be well attended by representatives of trading and manufacturing concerns in Great Britain. Those members of the British Association who are visiting East Africa after the South Africa meeting would probably find it interesting to break their journey at Dar es Salaam to visit the exhibition.

AUSTRALIA has large tracts of land with a soil and climate well adapted for dairying and beef production. These fertile areas have, however, not yet been fully developed and are very sparsely populated. If this Dominion is to maintain its 'all white' policy, it is necessary that the settlement of these lands should be accelerated. The best means of accelerating the settlement is by increasing the prosperity of primary industries based on the land. During the present year, at the invitation of the Australian Government, Sir Arnold Theiler, formerly director of the Veterinary Research Station at Onderstepoort, South Africa, and Dr. J. B. Orr, director of the Rowett Institute, Aberdeen, visited Australia to meet the executive of the Council of Scientific and Industrial Research, and research workers, to discuss the organisation and extension of research in animal health and animal nutrition.

DR. ORR was able to stay in Australia for only a few weeks, but Sir Arnold Theiler made an extended tour of six months' duration, during which he was able to make observations on some of the common animal diseases in Australia and offer valuable suggestions with regard to the efforts being made for their elimination. Both of these authorities have submitted reports with recommendations for the development of research in their respective subjects. The reports emphasise the value of the work already being done in Australia, but agree that there is still a vast field for applied science, and that the co-ordination and extension of research effort is likely to yield economic results through the decrease of disease and the increase of production. It is understood that the Council for Scientific and Industrial Research has decided to undertake an extensive research scheme on a Commonwealth basis, and that work under the scheme is likely to be begun in the immediate future.

THE function of a telephone circuit is to convey ideas from one person to another, and hence a measure of the efficiency of the circuit is the ratio of the number of ideas transmitted to the total number of ideas sent over the circuit. The value of this fraction is called the 'intelligibility' of the circuit. Its value is obtained by speaking a number of sentences, so designed that each conveys a single intelligible idea, into the microphone, and a listener at the telephone recording what he thinks he has heard. An example of a sentence used is 'The man hit the big dog.' The method is laborious, since a large number of such sentences must be spoken before a trustworthy average can be obtained. This and similar problems are ably discussed in a paper by Mr. John Collard, entitled "A Theoretical Study of the Articulation and Intelligibility of a Telephone Circuit," published by the International Standard Electric Corporation, of Connaught House, Aldwych, London. Mr. Collard points out that from the subscriber's point of view the efficiency of a telephone circuit should be judged by the relative time required to convey a given number of ideas over the circuit. For this purpose a quantity called the 'time efficiency' is defined. It is the ratio of the time required to transmit a given number of ideas over an ideal circuit to the time required to transmit the same ideas over the given circuit.

MANY other quantities are considered by Mr. Collard in his paper; as, for example, the 'syllable articulation' obtained by speaking a number of random syllables into the circuit. The results obtained are wonderfully constant, and the author develops a theory which gives algebraical relations between the various quantities. When a telephone circuit passes through different countries, it is usual to standardise the language of one of the countries as the operating language. So far as 'intelligibility' goes, the Italian language is the best, and next come German, English, and French. The actual time, however, to transmit a given number of ideas over a telephone circuit is least for French, and then come English, German, and Italian. It is best, therefore, to use a language like French or English. It is quicker to speak a language of short words, even when some of the sentences have to be repeated owing to the low intelligibility, than to speak a language of long words which has a relatively high intelligibility.

MANY reasons are given to explain why so many countries in Europe have electrified their main railway lines. Two of the most popular reasons given are either that they desire to be independent of foreign coal supply or that, as in Switzerland, they desire to make use of their waterfalls. Neither of these explanations has anything to do with the electrification of the main railway connecting Rotterdam and Amsterdam, two of the most important towns in Holland. In this case it was simply that the continually increasing volume of traffic made it difficult for steam locomotives to work the line satisfactorily. Although the section from Rotterdam to the Hague had been operated by single phase current since 1908, it was decided a few years ago to adopt direct current at 1500 volts, which is now the standard system in England and France. A description of the substations and rectifier apparatus for converting the a.c. generated into d.c. for the locomotives on the Dutch railway is given in the *Brown Boveri Review* for December. This is the first time that fully automatic rectifier substations have been employed in Europe for a main line railway. From the data given in this paper we learn that mercury arc rectifiers enclosed in steel cylinders are being widely

used for converting alternating current into direct current for traction purposes. As compared with rotary converters this method has advantages. The efficiency of the converters is more than 95 per cent, the yearly cost of maintenance is small, and an appreciable saving in labour is effected by their use. These high-power rectifiers seem particularly adapted for traction work and have been working satisfactorily for several years. The New South Wales Government will soon have ten 1500-kilowatt automatic rectifier equipments on its railways and tramways.

The catalogue of spectrometric apparatus which has just been issued by Messrs. Bellingham and Stanley, Ltd., contains particulars of new apparatus. One of the most interesting instruments is a small quartz spectrograph of the Littrow type, which is supplied at the low figure of £18, 10*s*. Unfortunately, the dispersion given by the instrument is not stated, but it is recommended for chemical analysis, particularly for quantitative work, depending on relative intensities of lines, and for the examination of many of the non-ferrous metals. Another quartz spectrograph, of entirely new design, is arranged so that the slit and photographic plate are horizontal. This facilitates observation of the spectrum, particularly for the study of fluorescence, and permits greater rigidity than the ordinary arrangement. A dispersion of 130 mm. between the wave-lengths 6000 and 2100 A. is produced, and the price of the spectrograph is £65. Another useful instrument, designed for the examination of the spectra of feeble sources of light in the visible region, is a glass spectrograph of the ordinary type, of which the lenses have an effective aperture of F/2 and a focal length of 5¼ in. It is specially recommended for the study of fluorescence, spark spectra, and neon stroboscopic photography. The cost is £190. For the comparison of spectra taken on different plates, a simple spectro-comparator has been designed at £17, 10*s*., with an additional charge of £6, 5*s*. for optional accessories. It is specially intended to facilitate chemical analysis, and is recommended in particular for determining the exactness or otherwise of apparent coincidences of spectrum lines when high dispersion is not available. Several other instruments also are described in the catalogue. Messrs. Bellingham and Stanley's work is known to reach a high standard of excellence, and their instruments may be depended upon to do all that is claimed for them.

Dispatches in the *Times* of Dec. 22 and 27 from Sir Hubert Wilkins and his pilot, Lieut. C. B. Eielson, announce important discoveries in the Antarctic. The expedition had been waiting at Deception Island for some weeks for favourable conditions for the aerial survey work which is planned, and it was not until Dec. 19 that Sir Hubert and Lieut. Eielson were able to set out in their Lockheed monoplane. They made a flight of about 1200 miles, during which they found that Graham Land is an island separated from the Antarctic continent by an ice-filled channel, and discovered six hitherto uncharted islands. Taking a southerly course from Deception Island across the Bransfield Straits, they reached Graham Land; an ice shelf appears to cut Graham Land in half, the northern portion being a table-land while the southern half is more irregular, with mountains rising to 8000-9000 ft.; the coast line is much indented. About Lat. 70°-71°, Long. 60°-70° is apparently low-lying land, mostly snow-covered, and immediately to the south is a strait 40-50 miles in width. Beyond this strait is the ice cliff bordering the Weddell Sea. At this point the monoplane was turned back and reached Deception Island safely, having been nine hours in the air. Sir Hubert Wilkins is to be congratulated on the good beginning to his projected survey of the coast line of the Antarctic continent.

The curtain was finally rung down upon the Glasgow meeting of the British Association on Wednesday, Dec. 19, at a meeting held in the City Chambers, Glasgow, when final reports were received, the actions of the various committees approved, and the local executive committee discharged. Various speakers, including the Lord Provost, who presided, and Principal Sir Donald MacAlister, gave expression to the widespread feeling of gratification that the citizens of Glasgow had done their part so well in making the meeting a success. Attention was directed to the fact that, thanks to the skilful administration of the honorary treasurer, Sir John Samuel, the finance committee was in a position to make a return of five shillings in the pound to subscribers to the guarantee fund. Cordial votes of thanks were accorded to the Lord Provost, Sir Donald MacAlister, and others who, as officials or members of committees, had contributed to the success of the meeting; and more than one speaker emphasised in particular the immense debt due to the administrative genius, accompanied by unstinted labour, of Sir John Samuel, who filled the office of acting secretary in addition to that of honorary treasurer.

On Dec. 20, Mr. J. Swinburne gave a historical account of the invention and development of the Swan carbon incandescent lamp to the Institution of Electrical Engineers. This lamp was first shown in public at Newcastle-on-Tyne on Dec. 18, 1878, fifty years ago. The invention of a platinum-iridium lamp by Staite in 1845 first directed Swan's attention to the possibilities of an incandescent lamp. He carbonised narrow strips of paper and lighted some of them with a battery of 50 cells, but they soon burned out. This was between 1855 and 1860. A few years later, the Sprengel pump was invented and electric lighting became a possibility. Swan then associated with C. H. Stearn, an enthusiast in high vacuum work. When a straight carbon conductor was used, variations in its length and local heating at points on the filament caused great difficulties. Swan's first good results were obtained with thin straight carbon rods. These lamps were exhibited in 1878. In 1880 he found that he got better carbons by using parchmentised paper, such as is made for covering jam jars. Good results were obtained by treating knitting cotton with sulphuric acid of suitable strength and washing and drying it. In 1884–85, Swan, assisted by Stearn and Topham, worked out the squirting process, using pyroxylin and reducing it. Other makers then

adopted other solutions in a similar way. Hence Swan, working almost independently, developed and produced the carbon incandescent lamp which was almost universally used until the advent of the tungsten filament.

THE Society for Experimental Biology held a conference at University College, London, on Dec. 14 and 15. Among many interesting papers, Dr. R. K. Cannan gave an account of modern views of oxidation systems in the cell; Miss A. M. Copping and Prof. J. C. Drummond reviewed the controversy as to the necessity of 'bios' for yeast growth, and showed that the disagreement between various workers is attributable to variations in different yeast species employed. Dr. H. A. Harris gave an analysis of the conditions required for proliferation on one hand, and differentiation on the other, in the development of tissues. During the third session a series of papers on the relation of anterior pituitary to sterility and on the nature of pseudopregnancy were followed by an excellent discussion led by Dr. B. P. Wiesner and Dr. A. S. Parkes. In the second session many demonstrations were given; Prof. J. Brontë Gatenby and his colleagues showed a beautiful demonstration of Golgi bodies, vacuome and mitochondria stained *intra-vitam*, and Dr. E. Bozler gave convincing illustrations of his interpretation of muscle structure in various phyla of the animal kingdom.

WE much regret to announce the death, which occurred on Dec. 23, of Sir William Thiselton-Dyer, K.C.M.G., C.I.E., formerly Director of the Royal Botanic Gardens, Kew, at the age of eighty-five years.

THE triennial award of the Coopers Hill War Memorial prize and medal, which fell in 1928 to the Institution of Electrical Engineers, has been made by the Council to Mr. W. Phoenix for his paper on "Electricity in Agriculture, with special reference to Electro-Culture."

A NEW publication, entitled "Civil Aeronautics," compiled by the office of the Legislative Counsel, United States Senate, has been issued by the Government Printing Office, Washington, D.C. It contains 178 pages, full of valuable information regarding the legislative regulation of civil aeronautics. It contains the text of the Air Commerce Act of the United States, of 1926, and material relating to the legislative history of that act, including committee reports, and a comparison of the bills as passed by the Senate and by the House; extracts from reports and articles on the legal problems of civil aeronautics, including publications of the American Bar Association and the Conference of Commissioners on Uniform State Laws; extracts from reports on legislation on civil aeronautics of the States of the United States, including decisions of State courts, and the text of international agreements relating to civil air navigation. The entire field of the legislative regulation of civil aeronautics is covered comprehensively right up to Aug. 1, 1928. Among the valuable articles included in it are several reports prepared by the Committee on Air Law of the American Bar Association. Copies of this publication may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D.C.

Our Astronomical Column.

THE COOKSON FLOATING ZENITH TELESCOPE.—This instrument was designed by the late Mr. Bryan Cookson, and presented at his death to the University of Cambridge Observatory; it was in use there for two years, and was lent in 1911 to the Royal Observatory, Greenwich, where it has been in use from 1911 to the present time. The observations are discussed in periods of seven or eight years, in order to separate the annual term from the 14-month term in the variation of latitude. The discussion of the observations of the second period (1919–1927) has just been published by the Royal Observatory in a small volume of 67 pages.

The Talcott method of observing pairs of stars at equal distances north and south of the zenith is employed. The trails of the stars are recorded photographically. The telescope is floated through 180° in its circular trough of mercury between the exposures.

The final value for the aberration constant from the whole period 1911–1927 is $20{\cdot}445'' \pm 0{\cdot}009''$. The second period (1919–1927) gave a value 0·005″ greater than the first (1911–1918). Taking the velocity of light as 299797 km./sec. (Mt. Wilson, 1926–1927) and the equatorial radius of the earth as 6378·355 km., the resulting solar parallax is $8{\cdot}815'' \pm 0{\cdot}004''$.

A plate shows graphically the variations of latitude for the fifteen years 1912–1927; the results of the international latitude stations are shown for comparison. On the whole, the agreement between them is very good. The chief differences are in 1916, where the Greenwich maximum is distinctly higher than the other, and in 1919, where Greenwich shows an abnormal minimum that is only faintly hinted at in the international curve.

VARIATION IN LIGHT OF POLARIS.—This star was for some time taken as a standard in stellar photometry, which makes the accurate determination of the period and amount of its light change of special importance. *Bulletin of Astron. Institute of the Netherlands*, vol. 4, No. 160, contains a discussion of it by A. de Sitter. He uses seventy-eight pairs of plates taken at Leyden by N. W. Doorn, between July 1925 and July 1928; he combines the results with those of eight other determinations, extending back to 1879, and obtains the period 3·968148 days $\pm 0{\cdot}000055$. The variation is analysed as a simple sine-curve, which appears to give a sufficiently good representation.

DIMENSIONS OF THE PLANETS.—W. Rabe gives an exhaustive discussion in *Astr. Nach.*, No. 5601, of the most probable values of the diameters of the planets. He collected all the most trustworthy measures, in which he included some recent ones of his own. Taking the solar parallax as 8·80″, he finds the following diameters in kilometres: Mercury 5140; Venus 12,620; earth (equatorial) 12,756; Mars (equatorial) 6860, (polar) 6820; Jupiter (equatorial) 143.600, (polar) 134,800; Saturn (equatorial) 120,600, (polar) 109,000; Uranus 53,400; Neptune 49,700. Outer diameter of Saturn's ring 278,500; inner diameter of crepe ring 144,000.

Research Items.

LIONS IN EUROPE.—It is known that lions inhabited Europe in historical times; the fact is mentioned by both Herodotus and Aristotle. Herodotus (480 B.C.) even determines the area in Macedonia inhabited by lions, and recounts that during the march of Xerxes through Macedonia, lions attacked and destroyed the Persian carrying camels. Aristotle (384–322) speaks of the same area, but mentions that lions are rare there. There are no later indications of their occurrence. Some investigators (O. Keller) do not attribute much value to this ancient information, supposing the group of lions to have been brought by Persians during their previous campaigns, which had lingered for more than a hundred years in the wild mountains of Macedonia, whilst the majority holds that the Macedonian lions were the last of lions, spread throughout Europe during the Pleistocene age, which later, under the oppression of man and deteriorating conditions of life, trekked south. Whatever may have happened, the existence of lions in Europe in historical times is not affirmed by any palæontological discoveries, and in this sense the discovery to which we are referring is unique. V. Gromova, in *Priroda* No. 10, mentions that among the rich palæontological materials collected by the Russian Academy of History of Material Culture between the years of 1901–1927, in the district of the rich ancient Greek city Olvia in S.W. Russia, a piece of the upper jaw of a lion, together with the upper canine tooth, was found. The tooth differs greatly from the canine tooth of a tiger by its shape, and from that of the other members of the cat family by its large size. However, as there was only one such discovery, its explanation should be approached with great care. It is quite probable that the lion was brought from Asia Minor, where the existence of lions, even up to the Mediterranean, in ancient times, is confirmed by a series of literary notes and discoveries of bones. It is well known (O. Keller, "Die Antike Tierwelt," pp. 29-31) that people of distinction and their wives kept lions as domestic pets, which accompanied them during walks, campaigns, etc. Above all, lions played a prominent part in the circus fights. It is quite probable that such is the origin of the Olvian lion; moreover, the solitary tooth is of the small size, such as is found in lions kept in zoological gardens only, and probably denotes a sign of degeneration. Thus the palæo-zoographical value of the discovery remains doubtful.

FRESH-WATER EELS OF NEW ZEALAND AND AUSTRALIA.—In the course of his work on the freshwater eels of the genus *Anguilla* throughout the world, Prof. Johs. Schmidt has now come to those of New Zealand (*Trans. N. Z. Inst.*, vol. 58; 1927) and of Australia (*Records Aust. Museum*, vol. 16, No. 4; 1928). In both papers the author emphasises the necessity of employing numerical characters, such as the number of vertebræ and of fin rays, in the identification of species. In the case of the New Zealand eels, however, he finds that the number of vertebræ is not such a good distinctive character as in most other cases. The distance between the front of the dorsal fin and the vent $(a-d)$, expressed as a percentage of the total length (t), is the most important distinguishing feature. Two valid species of *Anguilla* are thus found in New Zealand—*A. aucklandi*, in which the average value $\frac{a-d}{t} \times 100 = 11{\cdot}05$, and *A. australis* with an average value of 2·41. The former is distributed mainly in the south and west, the latter mainly in the north and east, but further data are required on this point. On the continent of Australia four species of eel are recorded—*A. australis*, *A. reinhardti*, *A. obscura*, and *A. bicolor*. Of these, the last named is an Indian form found in north-west tropical Australia. The three others are Pacific forms found on the east coast, one of which, *A. obscura*, is represented by only one specimen from the Burdekin River in the tropical part of Queensland. Between the *A. australis* of Australia and New Zealand there is an average difference of one vertebra, which in the author's opinion indicates a difference in their life history and breeding places. These two papers on *Anguilla* are of particular interest and value, not only as further contributions to our knowledge of that genus, but also as examples of the application of variational statistical methods to the identification of species.

INHERITANCE OF WEIGHT IN RABBITS.—In former crosses between large and small rabbits by Punnett and Bailey and Castle, the large size was not recovered in F_2, and it appeared that inheritance of weight might not conform to ordinary Mendelian behaviour. But the numbers of animals bred were not very large. Mr. Michael Pease (*Jour. of Genetics*, vol. 20, No. 2) has since repeated these experiments on a larger scale. He crossed a Polish doe with a Flemish buck and bred an F_2 numbering 309 animals. The complete range of adult weights was obtained, from the mean of the small Polish stock to beyond the mean of the large Flemish stock. It thus appears that weight in rabbits can be explained on the multiple factor hypothesis. The mean weight for the Polish stock was about 50 oz. and for Flemish twice as much. The F_1 was intermediate and showed no sign of hybrid vigour. Only a few F_1 animals gave the whole range of weights in F_2, the majority giving a much more restricted range. Some of the light F_2 animals bred true in F_3, but no heavy animals bred true. It is not decided whether there is one predominating weight factor; but it is concluded that the weight factors act in a logarithmic manner. The Polish stock appeared to contain a simple factor for sterility, but there was also a slowly diminishing fertility which must be otherwise explained. The growth curve and times of maturity of these rabbits has also been carefully studied, as well as the relation of weight to sex, colour, and size of litter. From the F_2 population one strain was selected which matured in 172 days, and another in 300 days. In many of these rabbits there is no correlation between heavy weight and slow maturity.

CHROMOSOMES OF THE EARTHWORM.—L. Monné (*Bull. Int. Acad. Polonaise Sc.*, B; 1928) has investigated the chromosomes of the earthworm *Allolobophora fœtida* and finds that in the cells of the epidermis, nervous system, gut epithelium, and the developing muscles, nephridia, and septa, the number is 22, 11 pairs. The oogonia are known to have 22 (Foot and Strobell) and the author finds the same number in the spermatogonia.

PAIRING AND OVIPOSITION IN THE INDIAN APPLE-SNAIL.—Prof. K. N. Bahl (*Mem. Ind. Mus.*, **9**, pp. 1-11; 1928) records observations on pairing and oviposition in the Indian apple-snail, *Pila globosa*. After a prolonged period of æstivation underground during the dry months, these snails come to the surface at the outset of the rains and at once pair in water on the ground at the edge of a pool. Pairing may last three hours, during which time the copulating animals may be handled and the principal relations of the male and female ducts ascertained. Prof. Bahl found that by electrocution he was able suddenly to kill a

couple of pairs, and by subsequent dissection to make out the precise details of the copulation. The vas deferens of the male terminates in a papilla lying in the mantle cavity close to the rectum. The penis-sheath and penis are outgrowths of the mantle and are independent of the male opening. Transference of the sperms from the vas deferens to the penis after the latter has been inserted into the mantle cavity of the female is effected by the genital papilla at the end of the vas deferens being directed into a depression at the proximal end of the penis. The sperms then pass along the penis into the aperture of the vagina of the female. Deposition of eggs takes place a day or two later in some sheltered hollow in the ground. Each egg, after passing out of the vaginal opening, travels down an oblique tube formed by two temporary folds on the right side of the foot and is delivered into a dome-shaped cavity under the foot formed by the arching of the creeping sole. Each egg has a sticky covering, so the eggs, from 200 or 300 to 800 in number, adhere to form a mass. When egg-laying is completed the snail leaves the egg-mass; there is no incubation of the eggs.

CROSSES BETWEEN WHEAT AND RYE.—Successful reciprocal crosses between wheat and rye are reported from the Saratov Experiment Station by Miss Nina Meister and Mr. N. A. Tjumjakoff (*Jour. of Genetics*, vol. 20, No. 2). The variety of wheat used was *Triticum vulgare* var. *erythrospernum*, and the rye was a local Russian form, 'Jelissejev.' It was found that the reciprocal hybrids were alike, both resembling wheat and both sterile. This is to be expected, since the wheat supplies 21 chromosomes and the rye but 7. No F_2 could be obtained, but the F_1 plants were crossed back with wheat or rye. The pollination of rye by wheat appears now to be accomplished for the first time. It is much more difficult than the reciprocal, giving only 2·5 per cent of successful fertilisations, as against 60 per cent for wheat and rye. These results are very different from those obtained by Gaines and Stevenson in 1922, and it is suggested that the rye-plants obtained by them from rye and wheat were not true hybrids.

BOTANICAL CARTOGRAPHY OF EUROPEAN RUSSIA.—The geo-botanical department of the Leningrad Botanical Garden started some years ago, under the general editorship of Prof. N. I. Kusnezow, and with the co-operation of a number of Russian botanists, the compilation of a botanico-geographical map of European Russia on the scale 1 : 1,050,000, that is, approximating closely to the scale 1 : 1,000,000 suggested for the maps of this kind by the International Botanical Congresses. The whole map will be on twenty sheets. Ten of these are ready, and three are already published covering the south-eastern provinces, that is, the regions adjoining the middle and lower course of the Volga and the Caspian steppes. The map is produced in colour and shows the distribution of different types of vegetation and partly even of the various associations. As admitted in the explanatory pamphlet (such pamphlets, containing a brief description of the vegetation of the respective areas, will be published with each sheet), the map is not equally exact in all details, since it it based on numerous disconnected local vegetational maps, reports of expeditions, etc. Some corrections will therefore be necessary after more detailed studies, and one of the main purposes of the map is to get together all results of previous botanico-geographical explorations, so that the gaps will be obvious and may be filled. Thus, the map is regarded as only the preliminary to another on the international scale. Apart from the vegetational map, an additional sheet, on transparent paper, has been published with the fourteenth sheet (middle Volga region), showing some floristic data (limits of distribution of various typical plants) and the boundaries of the glacial deposits. A general map of the vegetation of European Russia, on the scale 1 : 4,000,000, on a single sheet prepared by Prof. N. I. Kusnezow, has also been just published by the Leningrad Garden.

MARINE MOLLUSCA OF THE CHATHAM ISLANDS.—Collections of shells were early made from the Chatham Islands, and Capt. Hutton in his "Catalogue of the Marine Mollusca of New Zealand," 1873, was the first to give a connected account of their fauna. Collections from several sources have now been studied by Dr. H. J. Finlay (*Trans. New Zealand Inst.*, vol. 59), who is able to record the occurrence of 202 species, of which 30 appear to be endemic. The author considers that the present fauna is not a remnant, or evolution of the Tertiary faunas found there, but a repopulation from the mainland in post-Pliocene times, yet still long enough ago for characteristic regional species and subspecies to have evolved. The active factor in this repopulation has been ocean currents, acting from both north and south, but predominantly the latter. In this list Dr. Finlay treats all group names equally as full genera, this being in his opinion the handiest method for future reference, a course which those who have to consult the list, however, will scarcely agree with him is a matter of "no inconvenience." A more serious drawback to the list is that Dr. Finlay has followed the order of families and genera given in Hedley's "Check List of the Mollusca of New South Wales." He has fortunately reverted to the usually adopted order of the classes, but a very cursory inspection would have shown him that the whole of Hedley's MS., confessedly sent off to the printer at short notice, must have got badly disarranged ere it reached the compositor, and never have been submitted in proof to the compiler. How else to account, amongst other lapses, for the presence of the Gymnoglossa and the Architectonicidæ in the Opisthobranchia? It is a great pity that further currency should now be given to this unfortunate jumble. Nevertheless, Dr. Finlay's list will prove of great use to students of antipodean mollusca.

SUBMARINE WAVES IN GIBRALTAR STRAITS.—An upper lighter layer of variable depth lies upon denser water below; this upper, less saline, layer streams from the Atlantic into the Mediterranean, while the more saline water below runs out into the Atlantic, a certain amount at the boundary between the two layers mixing with the water above and being carried back into the Mediterranean. G. Schott, in the *Journal du Conseil International pour l'Exploration de la Mer* (vol. 3, No. 2, September 1928), reviews the available data bearing upon undulations which have been observed to occur in the boundary between the two layers. This rises and falls twice a day with a well-marked tidal period, the rise taking place in the Straits while the tide is falling at Gibraltar. The amplitude of these submarine waves is considerable, water at 14° C. with a salinity of 37·4 per mille in the trough at 180 metres below the surface, rising to 100 metres below the surface when on the crest of the submarine wave some 7 h. 40 m. later. It is shown that the boundary between the two layers is nearer the surface in the area over the ridge between Gibraltar and Africa than on either side. The explanation of these movements of the boundary layer advanced by R. de Buen, as 'injections' of water from below into the upper stratum, is disproved.

THE DIFFRACTION OF ELECTRONS BY MICA.—A note published by S. Kikuchi in the October number of the

Proceedings of the Imperial Academy of Tokyo contains a remarkable reproduction of an electron diffraction pattern. It was produced by passing a pencil of cathode rays—rendered homogeneous by magnetic sorting—through a very thin sheet of mica, and more than one hundred and fifty spots appear on it. They are arranged in an equilateral triangular pattern, from the dimensions of which the spacing of the molecules in the mica was calculated to be 5·11 A., the corresponding value obtained by an X-ray analysis being 5·18 A. The author has also had under investigation the relative intensities of other types of diffraction beams that are produced when electrons pass through thicker pieces of mica, and finds that there is a close parallelism betweem the distribution of intensities in electron beams and in the analogous beams of X-rays. The same is true of beams reflected from the cleavage faces of crystals, and electron diffraction has now been observed in this way with calcite, mica, topaz, zincblende, and quartz.

ELECTRON WAVES.—A very simple and convincing demonstration of the undulatory properties of electrons has been given by E. Rupp, who has described in a recent paper in the *Zeitschrift fur Physik* (vol. 52, p. 8) how they may be diffracted by a ruled metal grating, with rather more than a thousand lines to the centimetre. His apparatus was essentially a spectrometer of the type used for obtaining X-ray spectra at grazing incidence under similar conditions, the electromagnetic waves being replaced by slow cathode rays moving with speeds corresponding to between 70 volts and 300 volts. The set of spectrum photographs which has been reproduced shows distinctly that the cathode ray pencil passes away from the grating in certain privileged directions, as many as three orders of interference being apparent in one instance. The quantitative agreement of the results with the de Broglie wave theory is also satisfactory, the predicted and measured wave-lengths of the electrons agreeing to within a few per cent, whilst there seems to be no need to invoke the presence of an internal potential of the solid in this case. No evidence was found that the electron waves were polarised, the author's conclusions in this connexion being confirmed by some new experiments by Drs. Davisson and Germer which are mentioned in a recent *Bulletin* (No. 5) of the American Physical Society.

RADIUM AND GEOLOGY.—A short account by C. S. Piggot of the relationship of radioactivity to geological phenomena is given in the *Journal of the American Chemical Society* for November. There are three aspects of the problem, namely, the determination of the amount and distribution of radium throughout the lithosphere; the heat energy made available and the part it plays in mountain building; and, lastly, the estimation of geological time from the uranium-lead ratio. The amount of radium present in a rock may be determined by decomposing it by fusion with a flux and measuring with an electroscope the radium emanation thus liberated. The estimation of the age of a mineral from the uranium-lead ratio cannot be entirely trustworthy until further data are available concerning the disintegration of the thorium series. A measure of the relative amount of the lead derived from uranium would remove further uncertainty, and the author describes a method by which it is hoped to determine this by using Aston's mass-spectrograph.

AUTOMATIC SUBSTATIONS IN INDIA.—The development of automatic electric substations with supervisory control is making rapid progress. In the *Metropolitan Vickers Gazette* for October there is a full description of the use made by the Bombay, Baroda, and C.I. Railway of automatic stations. The economic value of these automatic stations is now widely recognised. By their use the capital expenditure on buildings is reduced and there is a large saving in wages. Complete and immediate information is given to the engineers at the generating station by means of suitable visible and audible signals. There is no loss of time in receiving telephone reports and transmitting instructions to operators. Should any machine become overheated, the fact is automatically signalled to the control office. A red lamp glows on the symbol for the machine on the control panel and an alarm bell rings. The supervisor then starts another set and the red lamp glows until the overheated machine cools to its working temperature. Blue lamps indicate when fuses blow, and when the fuse is replaced all the lamp signals are automatically checked. Yellow lamps glow intermittently when selecting impulses are being sent out from the panel. These and similar devices make supervisory control very effective. Owing to the lack of skilled operators, it is particularly useful abroad. The B.B. and C.I. Railway is claimed to be the largest and busiest in India, and the electrified section has the heaviest traffic. All the electric power is got from the Tata hydro-electric station situated in the Western Ghats, about 100 miles distant from Bombay. It is transmitted by three-phase alternating currents at a pressure of 110,000 volts. It is transformed to 22,000 volts, and then transmitted by underground cables and overhead transmission lines.

PERMALLOY ON SUBMARINE CABLES.—In a paper communicated to the Royal Society in 1855, Lord Kelvin laid the foundation of the theory of submarine telegraphy. This theory has since been greatly developed by mathematicians, and recently the discovery of magnetic alloys of constant permeability has enabled the theory of Heaviside to be utilised in practice. Notwithstanding these great developments, comparatively little attention has been devoted to familiarising electrical engineers outside the small circle of submarine cable engineers with these advances. The paper read to the Institution of Electrical Engineers by A. E. Foster, P. G. Ledger, and A. Rosen on Dec. 6 was the first paper on the subject for about thirty years. The discovery of permalloy made possible the loading of telegraph cables and greatly increased the speed of signalling. They explained the precautions that have to be taken during manufacture and the subsequent process of annealing. A full description of the annealing furnace through which the cable passes is given. The inductance of the cable varies largely with the annealing temperature. Further experimental investigation seems necessary to determine the best cycle of temperatures for heating and cooling. The inductance also varies with the hydrostatic pressure. The troubles introduced into cable working by the presence of electric power cables near their ends are not serious. It is more difficult to overcome the interference due to natural causes. These causes seem to be of the same nature as 'atmospherics' in radio communication. Electromotive forces are set up and disturbances travel in both directions along the cable. These may originate anywhere along the line, but the evidence shows that the disturbances are very small when the depth of the cable is 500 feet. In order to get over interruptions due to natural phenomena, the earthing core is connected with the sheath at a point where the depth is at least 500 feet. In several cases, however, these situations are unfortunately several miles from the shore.

Combustion in Gases.

USEFUL service is rendered by *Industrial and Engineering Chemistry* to those engaged on the chemistry of flames in bringing together in a special number the papers presented at the symposium on combustion, held last September, by the Gas, Fuel, and Petroleum Divisions of the American Chemical Society.

The first paper is one that claims attention both on theoretical and practical grounds, for it sets out to explain what is happening in the ordinary 'diffusion flame' of a gas jet burning in air. The authors, Messrs. S. P. Burke and T. E. W. Schumann, seek to diminish the complexities of the problem by the use of a concentric-tube arrangement in which the inner tube conveying the combustible gas is half the diameter of the outer tube conveying the air or oxygen, and the flow of the two streams is maintained at an equal rate. Under these conditions, the authors claim that any increase in temperature due to the flame is counterbalanced by an increase in the rate of inter-diffusion, and that variations in pressure do not affect the size of the flame.

It will be noticed that such elongated flames as the authors employ are not strictly comparable with ordinary gas flames in air, which do not vary in height directly as the gas-flow, and are affected by pressure; but nevertheless the results obtained are interesting—especially the comparison of the analyses of the products taken along the axis of the flame, with the theoretical deductions from the assumption that the flame front represents the boundary where the diffusion of oxygen inwards is just such as will combine completely with the gas diffusing outwards.

An interesting contribution by A. G. Loomis and G. St. J. Perrott, of the Bureau of Mines, deals with the temperature of non-luminous flames determined by the optical method of Kurlbaum-Fery. The method depends on comparing the 'brightness' temperature of a solid radiator (heated electrically) with the brightness of the radiation from the gas-air flame coloured with sodium vapour at a given spectrum line. When the sodium lines from the coloured flame appear dark upon the brighter background of the continuous spectrum of the radiator the flame is cooler, but when the radiator is cooler than the flame, the sodium lines appear as bright lines. By adjusting the current through the tungsten-band lamp, the lines can be brought just to the 'reversal' point, when the temperature of the tungsten measured by the optical pyrometer gives the temperature of the flame —after correction for absorption by the focusing lens.

In this way the authors measured the temperatures of a solid air-gas flame (close to the orifices of the silica burners), when methane, propane, and carbon monoxide were mixed with different volumes of air. The percentages of gas giving the maximum flame temperatures were found to be:

	Per Cent of Gas.	Max. Temp. of Flame.
Methane	9·8	1876° C.
Propane	4·2	1930° C.
Carbon monoxide	36-37	1960° C.

To check the results the authors measured the temperature of a natural gas-air mixture by the reversal method, and by the method used in the National Physical Laboratory at Teddington, in which the relation between the heating current and temperature of a refractory wire *in vacuo* and in the flame is determined. By the reversal method the temperature of the flame was found to be 1750° C.; by the N.P.L. method the flame was 1770° C.

Prof. W. E. Garner discusses the effect of the presence of small amounts of hydrogen on the radiation of the carbon monoxide-oxygen flame measured through a fluorite window at the end of an explosion-tube 80 cm. long. Measurements made in his laboratory at Bristol show that the radiation from the flame is reduced to one-seventh by the addition of 2 per cent of hydrogen to the mixture, and the diminution is still considerable when the hydrogen is reduced to 0·005 per cent. A marked change in the radiation—it is almost step-like—was observed as the hydrogen content passes the 0·02 per cent point; this discontinuity would require for its explanation the occurrence of two different mechanisms of chemical action. As bearing on this, it may be recalled that Weston has shown that the spectrum of the flame of the well-dried carbon monoxide-oxygen mixture, fired under high pressure, is far more luminous than the flame produced in the presence of hydrogen, and this has been interpreted to mean that carbon monoxide may combine directly with oxygen and also indirectly by the reduction of steam.

Messrs. F. A. Smith and S. F. Pickering exhibited photographs of propane-air and acetylene-air flames produced by forcing the mixtures through a tube, and either allowing access of secondary air or excluding it. In some cases the flames become polyhedral, and can be made to rotate slowly or rapidly according to the gas-content of the mixture.

A photographic study of the 'flicker' shown by ordinary luminous flames was presented by Messrs. D. S. Chamberlin and A. Rose, of the Lehigh University. With a kinematograph camera taking 32 pictures per second, the upper portion of the flames was shown to move upwards, and then to fall very rapidly, or be extinguished—for in some cases two completely separated flames are photographed on the same picture. With natural methane, ethane, and ethylene burning from an orifice rather less than 1 mm. in diameter, the rate of flicker was about 10 per second, and the amplitude about 4 to 5 cm.

Mr. F. W. Stevens, of the Bureau of Standards, has made photographic measurements of the spread of the flame in carbon monoxide-oxygen mixtures when fired centrally in soap bubbles, by which device the flame may be imagined to spread through a gas mixture unconfined in space—and under constant pressure. The flame was found to proceed at a uniform rate, but the rate deduced from the inclination of the line of the flame front (being the rate through space) is greater than the velocity of the 'reaction zone' relative to the gas it is entering. Mr. Stevens shows that the true rate of the flame is greatest with the theoretical mixture $2CO + O_2$. The rate of the flame in methane-oxygen mixtures has also been studied, and the author finds that when the methane is increased beyond that required for complete combustion, the rate of propagation of the reaction zone falls off abruptly. Generally, the author is convinced that the bubble is an efficient experimental gas engine operating with minimum heat losses and negligible friction against the pressure of the surrounding atmosphere.

The work of the Sheffield School (1) on the slow uniform phase of gaseous combustion, and (2) on the initial spread of the flame and its arrest when gas mixtures are fired centrally in a cylindrical tube, is summarised by Dr. Payman.

(1) The speed of flame in the limit mixtures (*i.e.* those just propagating flame) of various inflammable gases with air has been found to be close on 20 cm./sec.; but notable exceptions are presented by hydrogen and acetylene mixtures.

(2) When hydrocarbon-air mixtures are fired in the centre of a cylinder 5 cm. in diameter, and the flame is photographed on a moving film through a narrow horizontal window, the front of the flame towards each end is seen to increase in speed until it is suddenly checked and then proceeds at a nearly uniform rate to the end of the cylinder. As the point of arrest is shown to coincide with the moment when a belt of the expanding globe of flame reaches the cold walls, it is suggested that the arrest is due to the cooling (or extinction) of the flame by the contact, and to the consequent loss of pushing power behind the flame-fronts. Very rapid snap-shots of the flame in clear cylinders show that it starts as a sphere from the central spark, then becomes egg-shaped, and finally breaks into two when the equatorial belt reaches the side wall. The snap-shots also show the re-illumination of the central portion after the flame has reached the ends of the vessel, indicating that the combustion was not complete when the flame-front has traversed the cylinder.

Messrs. J. V. Hunn and G. G. Brown describe an apparatus in which the passage of a flame may be photographed on a moving film at the same time that pressures are registered at four points along a cylinder of 3 inches diameter. Using carbon disulphide with excess of oxygen, the authors show that a pressure-wave travels from the igniting spark ahead of the flame-front and, being reflected from the farther end, returns to the firing-end, passing through the flame *en route*; again reflected from the firing-end, but travelling faster through the heated gas, it may overtake the flame-front, and in so doing cause a halt and even a reversion of the flame. This is a new interpretation of the 'halt,' and one not easy to follow on the published photograph. Obviously the method is a promising one and should be pursued.

In the United States, where it is said a motor-car is registered for every five inhabitants, a conference on gaseous combustion was bound to deal with 'knock' and 'anti-knock.' Prof. Wheeler and G. B. Maxwell contribute the results of their experiments in a 6-inch cylinder of 15 inches length, in which pentane- and benzene-air mixtures were fired with a spark near one end-plate and a pressure-gauge in the other end. The flame was photographed through a narrow window. When a 3 per cent pentane-air mixture is fired at atmospheric pressure, the flame travels with accelerating speed until, just beyond half-way, it is checked and then proceeds slowly to the end: the pressure recorded shows an even rise, a check corresponding to that of the flame, and then a rise to the maximum when the flame reaches the end. When the pentane is increased to 3·5 per cent the flame begins to vibrate after the central check, and when it reaches the end sends back a very rapid luminous wave. With increase of initial pressure to 2 or 3 atmos., the explosions are distinctly audible, and the vibrations are more violent with the 3·5 per cent mixture. The gauge shows a sudden rise of pressure as the flame reaches the end, and the photographs show an intense glow traversing the cylinder. Similar benzene-air mixtures gave but feeble vibrations and no shock-wave.

The addition of lead tetra-ethide, 2·5 ounces to the gallon of pentane, greatly increased the violence of the explosion; but when the lead compound was first decomposed, and the cloud swept in with the charge, a continuous combustion was observed and no shock-wave was recorded. These experiments confirm the view of Egerton and Gates on the anti-knock effect.

Messrs. T. E. Layng and M. A. Youker describe a glass apparatus for determining the rate of oxidation of various fuels when heated in oxygen. They show that n-heptane is oxidised fairly readily at 160° C.; but this oxidation is prevented by small additions of lead ethide or of potassium ethylate. On the other hand, kerosene could be kept for eight hours in oxygen at 180° C. with very slight alteration; but the addition of 0·05 per cent of lead ethide to the liquid produced marked oxidation, while the addition of 1 per cent of aniline or of diphenylamine had no effect. It is suggested that an efficient anti-knock must retard gas-phase oxidation and accelerate liquid-phase oxidation.

Other interesting papers deal with the partial oxidation of methane and ethane in the presence of catalysts, and the relative rates of oxidation of the olefines in flames and liquid oxidising agents.

Development Commission Report, 1927–28.[1]

THE reports of the Development Commission show how great a stimulus the Development Fund has been to research in agriculture and horticulture since its introduction in 1911. Grants-in-aid prior to this were dispensed with a meagre hand, hence major investigations requiring a large equipment and manifold repetition, as in the case of animal diseases, could scarcely be carried on. This eighteenth report conveys, however, an impression that the progeny of the Fund have become too numerous, and that the expansion inevitable in scientific investigations has outrun the capacity of the Fund. Thus large supplementary grants have been given by the Empire Marketing Board to the Welsh and Scottish Plant Breeding Stations for buildings, etc., to research in woollen industries, and to agricultural economics research at Oxford.

The total advances from the Development Fund for 1927–28 were about £383,000, as compared with £403,000 the previous year. The ordinary Development Fund contributed £253,000, the residue coming from the Special Fund (Corn Production Acts, 1921), but this latter source appears from the accounts now to be exhausted. The larger part of the funds is applied in aid of two schemes, research institutes in agriculture and advisory centres. The grants detailed for each centre show little change from the previous year. The new grants include two for investigations on the virus diseases of the potato, to the Cambridge and Scottish Plant Breeding Institute, respectively. A committee set up to investigate foot-and-mouth disease received the substantial grant of £15,000. An important development, still in its initial stages, is the Scottish Dairy Research Institute, which has been rendered possible by a private gift of a mansion and estate at Auchencruive, near Ayr, valued at £20,000, and a bequest of £26,000. The Development Commissioners have agreed to recommend sums up to £52,000, subject to local contributions, over a period of four years.

Amongst the reports on institutes there is evidence of considerable activity in those devoted to horticulture, which appear to be well supported by grants.

Reference is made to the much debated subject, how best to secure co-ordination of research. This was discussed at some length at the Imperial Agricultural Conference in 1927, and at least one scheme was proposed for exchange of reports on work, which was over-elaborate. A summary of agencies available

[1] "Development Commission Report of the Development Commissioners for the year ended March 31, 1928." (London: H.M. Stationery Office, 1928) 3s. 6d. net.

in Britain for conference and exchange of information shows that home workers have reasonable opportunities, but there is still room for linkage with other parts of the British Empire. Endeavours have been made to fill the gap by conferences, but of course attendance is possible only for a limited number and at considerable cost.

This leads to the vexed question of technical publications. Few research institutes have libraries anything like adequate for their needs, and in recent years estimates for libraries have been severely pruned, and the situation exists that institutes receiving State aid have to purchase government publications at booksellers' prices. The same economy is evident when an institute wishes to publish its results, and to circulate them. Printing estimates are censored, so that authors must wait their turn for publication in journals already overcrowded.

The present report suggests that the policy to aim at is the wider distribution of semi-popular publications and bulletins. Much depends on the meaning attached to 'semi-popular,' for matter set out for a newspaper or a farmer's weekly would probably be of little use to the specialised investigator, but what the report suggests seems to be the condensed summary such as a specialist presents to his colleagues at a conference. Some good examples of the kind of information useful for co-ordination will be found among the summaries of work in this report. These occupy the greater part of the report, and with the appendices (30 pages) giving the titles of monographs, etc., published during the year by each institute receiving grants, indicate the wide field of research covered by the Development Fund.

University and Educational Intelligence.

LONDON.—The title of professor of zoology in the University has been conferred on Dr. H. G. Jackson as from Aug. 1 last, in respect of the post held by him at Birkbeck College. Prof. Jackson was appointed to the University readership in zoology at that College in May 1921, and has published numerous papers on isopods in the *Proceedings of the Zoological Society*, the *Annals and Magazine of Natural History*, and other biological journals.

IT is about two years since what is frequently referred to as the Hadow Report was issued. So powerful an impression did it make, and so widely was it discussed, that it seems almost unnecessary to explain that it was a report by the Board of Education's Consultative Committee dealing with the organisation, objective, and curriculum of courses of study for children (other than those attending secondary schools) who will remain in full-time attendance up to the age of fifteen years, regard being had to their probable future occupations. The report received almost general approval from all types of educational and social workers. The Board of Education has since issued its Circular 1397 and its "New Prospect in Education," in which it indicates how some of the recommendations of the Hadow Report may be applied to the educational system. In a pamphlet entitled "The Hadow Report and After," the Executive Committee of the National Union of Teachers has attempted to set forth constructive criticism of these documents. It is made clear that the purpose of any criticism is not to impede advance, but to offer the results of the N.U.T.'s experience in the solution of the very difficult problems involved. To the detailed arguments in chapters which include the regrading of education, unity in the post-primary system, barriers to unity, age of transfer, size of classes, and curriculum of the senior school, are added fifty-five recommendations. The work, which is being widely circulated to interested persons, ought to do much to stimulate thought in connexion with the important problems discussed. The pronouncements made, of course, are those of the National Union of Teachers; we cannot avoid feeling that, since other teachers' associations are so closely concerned, the securing and inclusion of their views would have been a considerable advantage.

THE Collège des Ecossais, founded by Prof. Patrick Geddes as a hall of residence for students pursuing courses of study in the University of Montpellier, has justified the hopes of its founder and demonstrated the existence of a demand for such accommodation in excess of its capacity. Plans have now been completed for erecting beside it a new and larger building. This will more than double the accommodation at present available, which only suffices for about twenty students. The foundation-stone of the new building was laid on Oct. 18 by the Rector of the University, M. Coulet, who, in his inaugural address, recalled the fact that Prof. Geddes had himself been a student there forty years ago, and emphasised the significance of the new undertaking as an agency promoting international understanding and world peace. The Mayor of Montpellier added his felicitations and promised to give all the help he could in regard to such matters as electricity and water-supply, while the Secretary-General on behalf of the Prefect hailed Prof. Geddes as a valued friend of France and of Montpellier. A telegram was received in the course of the proceedings from the Franco-Scottish Association of the University of Edinburgh, where Prof. Geddes is well known for his indefatigable labours in the cause of improving the conditions of residence of the students. At Montpellier special courses are offered by the faculty of sciences in chemical engineering and in œnology and there is a fuels institute for advanced students. In connexion with the zoological laboratories is a marine biological station at Cette. Attached to the well-known botanical gardens is the Mont Aigonal laboratory for research on mountain flora.

THE Royal Technical College, Glasgow, has sent us its report on the session 1927–28—the twenty-fifth since King Edward VII. laid the memorial stone of what is claimed to be the largest single structure in Britain devoted to education. Experience has demonstrated the enormous benefits accruing from the establishment under one roof of laboratories belonging to the various departments—physics, chemistry, metallurgy, engineering, bacteriology — formerly housed in seven detached, scattered, and obsolete buildings. It has also justified the extensive scale on which the chemical laboratories were planned—a scale strongly criticised at the time as extravagant. Since then much of the more elementary work and the whole of the craft classes have been transferred to the Glasgow Education Authority, and accommodation has thus been made available for a great expansion of advanced study and research in connexion with the countless scientific problems arising in the various industries with which the College is associated. The staff has increased during this period from 29 to 93. A significant event in the recent history of the College is the establishment of the New Development Fund initiated by the former chairman of the governors, Sir George Beilby, and indications of the success that has attended the administration of this fund are to be found in the fifty-eight original papers which have been published in the College *Research Journal*, now in its fifth year, and in the large and increasing number of requests from local firms for help in dealing with problems arising from the use of new alloys and other materials.

Calendar of Patent Records.

January 1, 1905.—Previous to 1905 no question as to the novelty of an invention for which a patent was being sought was raised by the British patent office, but under the provisions of the Patents Act, 1902 (2 Edw. 7, cap. 34), which came into force on Jan. 1, 1905, an official search for novelty was instituted; the examination, however, extending only to completed British patent specifications on applications not more than fifty years old. This limited search has not been altered by later Acts and is still the practice of the office, some 21,000 specifications being so examined each year.

January 3, 1561.—One of the earliest of English industrial monopoly patents was for the manufacture of soap. Soft soap was at that time the only kind made in England, and the patent is evidence of an attempt to introduce into this country the hard soap industry of Marseilles and Spain. The grant was for ten years from Jan. 3, 1561, to Stephen Groyett and Anthony Leleuryer to make white hard soap "like of goodness fynes and puritie as the sope is which is made in the sope houses of Triana or Syvile," and it contained a clause to the effect that two at least of the workmen were to be of English birth. The grant also stipulated that the soap was to be subject to inspection by officers appointed by the Lord Mayor and the Lord Chancellor, and that the patent would be voided if the soap were found to be deficient in quality. It is improbable that the invention was put into successful operation.

January 3, 1839.—The atmospheric system of railway propulsion attracted general attention in England and on the Continent during the forties of last century. Under it a train was propelled by means of atmospheric pressure acting on a piston working in a continuous tube laid between the rails, a vacuum being created in front of the piston by stationary engines situated at convenient intervals along the line. The piston was connected to the first carriage or 'locomotive' by means of a rod working through a slot in the top of the tube, and the great difficulty of the early experimenters lay in the design of a valve for the slot which would open and shut satisfactorily on the passing of a train. Samuel Clegg was the first to find a practicable solution, and he patented his invention on Jan. 3, 1839. In conjunction with Jacob Samuda, of the Southwark Bridge Iron Works, he laid a short length of line for the Dublin and Kingstown Company between Dalkey and Kingstown which was opened in March 1843. Other lines were projected, notably one from Croydon to Epsom and London, part of which was built and opened, but the cost of working and other difficulties proved too great, and all the lines were closed down before 1848.

January 5, 1769.—It is unnecessary nowadays to emphasise the fact that James Watt did not invent the steam engine, but his achievements nevertheless entitle him to rank as one of the world's outstanding inventors. His first engine—the patent for which was granted on Jan. 5, 1769—doubled the efficiency of the old Newcomen engine and directly contributed to the great expansion of industry that took place during the latter part of the eighteenth and the nineteenth centuries. In 1775, Parliament extended the life of the patent, and it was not until 1800, after Watt himself had retired from active business, that the monopoly rights expired. By this time the new business of steam and mechanical engineering, which the success of the Watt engine had called into being, was definitely established.

January 7, 1625.—Wheeled coaches were introduced into England about the middle of the sixteenth century, and became increasingly popular in spite of restrictive legislation which, until the coming of the Turnpike Acts, attempted to fit the traffic to the roads rather than to improve the latter. Many attempts were made to render the coaches more comfortable and safe. A patent was granted to Edward Knappe on Jan. 7, 1625, for a coach in which the wheels and axle-trees were so placed and constructed "as in an instant of tyme the wheels maie be shutt closer together where the narrownes of the waie shall require itt, without anie danger, or to be enlarged and sett wyder as shall be most safe and easey for the passenger . . . as alsoe by hanging the bodie of the coach to the carriage by two springs of steele before and two behinde for the more ease of the treveller." No specification was enrolled and nothing is known about the actual construction. Springs did not come into use until some time later.

January 7, 1714.—Though typewriters were not in general use until toward the end of last century, British patent records and those of other countries show that for a long period there had been a serious and sustained effort to solve the problem of 'mechanical writing.' The earliest patent for such a machine was granted in England to Henry Mill, the engineer of the New River Company, on Jan. 7, 1714, with the title "An artificial machine or method for the impressing or transcribing of letters singly or progressively one after another as in writing, so neat and exact as not to be distinguished from print." No description of the apparatus has come down to us.

January 9, 1854.—Glycerine was discovered by Scheele in 1779, but it did not find extensive application until very much later. It was known that it formed a large part of the spent lyes from soap-making, but there was no great demand for it and no suitable method for its recovery, the small quantities which were required for medicinal purposes being made by saponifying oil with litharge. It was not until G. F. Wilson, of Price's Candle Co., introduced the process of separating the glycerine from the fat acids by means of steam at a high temperature that a pure glycerine could be economically obtained in large quantities. Wilson's process was based on that of R. A. Tilghman, which consisted in forcing an emulsion of fat and water through a coiled pipe heated in a furnace to a temperature of about 330°, for which a patent was granted on Jan. 9, 1854. The discovery of nitroglycerine as an explosive by Nobel in 1863 greatly increased the demand for glycerine.

January 9, 1857.—'Aerated bread' was made under the patent (2293 of 1856) granted to John Daughlish, which was sealed on Jan. 9, 1857. The invention consists of a process for aerating the dough without the addition of yeast or the usual chemical compounds. Carbon dioxide is forced into water under pressure and the charged water is then used for converting the flour into dough, the operation being carried out in a kneading machine in which the pressure is maintained until the kneading is completed.

January 11, 1841.—Alexander Bain was one of the pioneers in the application of electricity to clocks, his first patent, which describes a master clock system, being dated Jan. 11, 1841. The pendulum of his clock carries a coil in place of the bob, which moves in the field of two fixed magnets with north poles adjacent, a make-and-break device regulating the current to the coil so that the pendulum receives an impulse once in every swing to the right.

Societies and Academies.

DUBLIN.

Royal Irish Academy, Dec. 10.—**A. Farrington**: The pre-glacial topography of the Liffey basin. In preglacial times the present Liffey basin was divided between the catchments of two separate streams. One of these catchments included the hill-encircled basin of the upper Liffey and the Kings River. From this area the drainage escaped in a westerly direction. The second catchment was that of the Rye-Water river, which flowed eastwards to Dublin Bay. The portion of the present Liffey which connects these two basins is post-glacial in date. The theory that the diversion of the upper Liffey was due to the lowering of the valley by glacial scour is discussed and rejected. The development of the present course of the Liffey is traced from its initiation as a consequent stream on a westward-sloping plain. This plain was certainly post-Cretaceous and is probably of mid-Tertiary age.

ROME.

Royal National Academy of the Lincei, Communications received during the vacation, 1928.—**G. Giorgi**: New observations on the functions of matrices.—**Q. Majorana** and **G. Todesco**: Preparation of the thallium photoelectric cell. A quick-acting photoelectric cell, at least as sensitive as that of Case, may be prepared from thallium sulphide.—**L. A. Herrera**: Imitation of organised forms by albumen and hydrofluoric acid. Treatment of egg-albumen with hydrofluoric acid, either pure or diluted with water or glycerine, gives rise to structures having the microscopic appearance of hyaline or granulated masses, either nucleated or non-nucleated.—**T. Boggio**: Riemann's homography relative to a curved space.—**J. Delsarte**: The composition of second space.—**H. Geppert**: Adiabatic invariants of a differential generic system. A rigorous definition is given of the conception of adiabatic invariant for any differential system; the problem of finding these invariants in the case of two or more dimensions is to be resolved later.—**R. Caccioppoli**: The definition of the area of a surface. The author's semi-analytic definition of the area of a curved surface, based on the notion of an element of area, is supplemented, and is shown to be of value in integrating and throwing light on certain recent observations of various authors.—**A. Rosenblatt**: The singularity of the solution of a system of ordinary differential equations.—**A. Signorini**: Asymptotic expression of a formula of Levi-Cività.—**E. Pistolesi**: Further observations on Kutta-Joukowski's theorem in the case of a plane lamina. From a discussion of various papers which have lately appeared on this subject, it is concluded that, owing to the essential singularities presented by the current at the angles of the lamina, the problem cannot be solved by the 'orthodox' methods of analysis, but that it requires treatment as a limiting case of a contour devoid of singularity which, by deformation, tends to become confused with the segment counted twice; that the suction at the corners, necessary for the validity of Kutta-Joukowski's theorem, naturally finds a place in the problem so considered; and that such validity may be assumed also for Cisotti's lamina and in all analogous cases.—**E. Persico**: Optical resonance according to wave mechanics. The approximate method proposed by Fermi for taking account of the reaction of radiation in wave mechanics is applied to the development of the theory of optical resonance from the point of view of Schrödinger's mechanics.—**R. Deaglio**: The Volta effect in air and moist surface films. Experiments show that, in a dry medium, the pile effect disappears completely, whereas the Volta effect remains practically unchanged. Hence the moisture of surface films, necessary to create the pile effect, is without sensible influence on the Volta effect.—**E. Oddone**: Interpretation of superficial seismic waves. Explanation of surface seismic waves is somewhat simplified on the basis of the probable existence of Mohorovicic's surfaces of discontinuity and on the values of the velocity of longitudinal waves in and beyond the earth's crust, 57 kilometres in thickness. The slow waves may be considered as analogous to the infra-sounds of acoustics, that is, as waves transformed by distance and multiple reflections.—**B. Castiglioni**: Circulation in the southern Adriatic (2). The currents governing the circulation of the water through the Straits of Otranto are discussed.—**G. Scagliarini** and **P. Pratesi**: The reaction between sodium nitroprusside and sulphides. Stable, homogeneous crystalline compounds, such as $K_2Fe(CN)_5NO, K_2S$, may be obtained by treating a dry nitroprusside with an anhydrous sulphide in absolute methyl alcohol solution. The action of the sulphide on the nitroprusside appears to be analogous to that of alkalis.—**P. Gallitelli**: Laumontite from Toggiano. Two types of laumontite exist: (1) a compact form of almost fibrous structure and nacreous lustre; and (2) a finely granular, almost earthy variety, which crumbles at the slightest shock and differs in composition from the other principally in its lower content of water. The percentage losses of water in the two cases are nearly the same for temperatures below 400°, but diverge at higher temperatures. It seems unlikely that the friable form has originated by dehydration of the more compact kind.—**M. Anelli** and **A. Belluigi**: Confirmation of geological inductions and of geophysical results.—**B. Monterosso**: Cirrepedological studies (4). Phenomena which precede anabiosis in *Chthamalus*.—**F. Dulzetto**: Observations on the sexual life of *Gambusia holbrooki* (Grd.). Contrary to statements made, the sperms of *G. holbrooki* are capable, under certain conditions, of preserving, in the body of the female, their fertilising power from one year to another. The sex of the generations produced in such conditions is under investigation.—**Maria De Cecco**: Application of ultraviolet rays to the examination of fluorescent substances in plants in relation to certain phenomena of vegetable pathology.

SYDNEY.

Linnean Society of New South Wales, Oct. 31.—**I. M. Mackerras**: New Australian Mydaidæ (Diptera). Description of five new species, one of *Diochlistus* and four of *Miltinus*, and notes on other species.—**J. R. Malloch**: Notes on Australian Diptera. No. 17. The paper contains notes on the Ceroplatinæ (fam. Mycetophilidæ), the genus *Pachyneres*, some Asilidæ, and some already described species of *Cyclorrhapha*.—**Rev. H. M. R. Rupp**: Notes on *Corysanthes* and some species of *Pterostylis* and *Caladenia*.—**H. J. Carter**: Revision of *Hesthesis* (Cerambycidæ) together with description of a new genus and species of Buprestidæ. Three new species (or subspecies) of *Hesthesis*, a new species of *Epania*, and a new genus belonging to the group Anthaxites of the Buprestidæ are described.—**I. V. Newman**: The life history of *Doryanthes excelsa* (Corr.). Part 1. Some ecological and vegetative features and spore production. The development of the floral organs suggests the leaf-shoot nature of the flower, the carpels showing very clearly the form of involute leaves. The microsporangium suggests that of eusporangiate Filicales. *D. excelsa* appears to be primitive among the Amaryllidaceæ.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 14, No. 10, Oct. 15).—**L. Brillouin**: Is it possible to test by a

direct experiment the hypothesis of the spinning electron? Suppose that a beam of electrons enters a weak magnetic field nearly normally; the electrons will begin to move in spirals towards the pole of the magnet, and an electrode placed near the pole would collect the electrons. If the electrons have an electric moment, the current to the electrode will drop suddenly to half its value as the direction of the incident electrons approaches the normal to the magnetic field. The experiment will be difficult to carry out.—**Benedict Cassen**: On the distribution law in locally rapidly fluctuating fields which are steady when averaged over a sufficient time interval. In determining the time average electrical potential round the nucleus of a heavy atom, the use of the statistical distribution law of an ideal gas in a steady field is not justified; a 'correlation potential' must be used.—**Frank Peat Goeder**: The crystal structure of potassium sulphate. A quantitative three-dimensional structure is proposed which gives diffraction effects in good agreement with those observed in X-ray powder photographs.—**Carl Barus**: Further experiments in microbarometry.—**Jos. E. Henderson and Elizabeth R. Laird**: Reflection of soft X-rays. The curves showing the relation between percentage reflection from glass and glancing angle have no discontinuity corresponding to a critical angle and total reflection such as is found with short wave-length X-rays. The results can be explained by taking into account the absorption.—**Mabel K. Slattery**: Fluorescence and solid solution. Small quantities of uranium dissolved in fused alkali fluorides gives brilliant and resolved fluorescence spectra at the temperature of liquid air. It seems that the uranium goes into uniform solid solution, replacing an atom of the alkali element here and there in the crystal lattice, and produces no measurable change therein.—**E. C. Kemble and V. Guillemin, Jr.**: Note on the Lyman bands of hydrogen.—**Lee A. DuBridge**: Systematic variations of the constant A in thermionic emission. A form of the Richardson-Dushman equation is developed in which the observed variations of A can be ascribed to a small temperature variation of the surface work function.—**R. C. Williamson**: (1) The photoelectric long wave limit of potassium vapour. There appear to be two types of *molecular* ionisation, one without and the other with dissociation.—(2) Emergent energy of photo-electrons in potassium vapour.—**Edwin H. Hall**: Electric conductivity and optical absorption of metals. An argument based on the associated-electron theory of conduction, namely, that conduction is partly by free electrons sharing the thermal energy but mainly by the interchange of electrons in encounters between atoms and positive ions, the latter being naturally equal in number to the free electrons.—**Clyde E. Keeler, Evelyn Sutcliffe, and E. L. Chaffee**: A description of the ontogenetic development of retinal action currents in the house mouse. Using the intact unanæsthetised animal, it is found that the first visible potential difference on illumination occurs on the 13th-14th day after birth. The reaction in young mice is different from that in older animals, but it gradually takes on the adult form.—**L. C. Dunn**: A fifth allelomorph in the agouti series of the house mouse.—**G. A. Miller**: Determination of all the groups which contain a given group as an invariant subgroup of prime index.—**Charles E. Hadley**: Colour changes in excised pieces of the integument of *Anolis equestris* under the influence of light. Patches of dorsal skin of this Cuban lizard in physiological salt solution in direct sunlight change from green to dark brown in 40 sec., and 12 sec. after removal to the shade become green again. Similar changes occur in the live animal, and also with the stimulation of excitement, but much more slowly. As regards the excised skin experiments, the melanophores must be capable of expansion and contraction when isolated from the action of hormones and the nervous system; possibly impulses are received from end organs left intact in the skin, or light may have a direct effect on the melanophores.

Official Publications Received.

BRITISH.

Proceedings of the Royal Society. Series A, Vol. 121, No. A788. Pp. 477-681+xlii. (London: Harrison and Sons, Ltd.) 8s.

Royal Agricultural Society of England. Agricultural Research in 1927. Pp. viii+190. (London: John Murray.) 1s.

Observations made with the Cookson Floating Zenith Telescope in the Years 1919-1927 at the Royal Observatory, Greenwich, for the Determination of the Variation of Latitude and the Constant of Aberration, under the direction of Sir Frank Dyson. Pp. 67. (London: H.M. Stationery Office.) 7s. 6d. net.

Department of Scientific and Industrial Research. Report of the Water Pollution Research Board for the Year 1927-8. Pp. iii+18. (London: H.M. Stationery Office.) 6d. net.

FOREIGN.

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 80. Fishes from Florida and the West Indies. By Henry W. Fowler. Pp. 451-473. (Philadelphia, Pa.)

Ministry of Public Works, Egypt. Physical Department. Paper No. 24: The Measurement of the Discharge of the Nile through the Sluices of the Aswan Dam, Final Conclusions and Tables of Results. By Dr. H. E. Hurst and D. A. F. Watt. Pp. v+44+4 plates. (Cairo: Government Publications Office.) 10 P.T.

Civil Aeronautics. Legislative History of the Air Commerce Act of 1926, Approved May 20, 1926, together with Miscellaneous Legal Materials relating to Civil Air Navigation. Revision of the 1923 edition of Law Memoranda upon Civil Aeronautics. Corrected to August 1, 1928. Pp. v+178. (Washington, D.C.: Government Printing Office.)

Reprint and Circular Series of the National Research Council. No. 83: Sixth Report of the Committee on Contact Analysis. By Robert E. Burk, in collaboration with other Members of the Committee. Pp. 47. 50 cents. No. 84: i. The Fourth Census of Graduate Research Students in Chemistry, 1927; ii. Support of Graduate Research in Chemistry in American Universities, 1927-1928. Compiled by Clarence J. West and Callie Hull. Pp. 13. 20 cents. (Washington, D.C.: National Academy of Natural Sciences.)

Cornell University Agricultural Experiment Station, Ithaca, New York. Bulletin 467: Tomato Fertiliser Experiments in Chautauqua County, New York. By Paul Work. Pp. 24. Bulletin 469: The Collection of General-Property Taxes on Farm Property in the United States, with Emphasis on New York. By M. Slade Kendrick. Pp. 51. (Ithaca, N.Y.)

Diary of Societies.

FRIDAY, JANUARY 4.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—Dr. H. R. Mill: Capt Cook's Quest of the Southern Continent (Christmas Lectures to Young People) (II.).

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Major A. W. Farrer: The Engineer Salesman Abroad.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Informal Meeting of Pictorial Group), at 7.—Discussion on the Prints in the Holcroft Collection.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Thomas' Café, Swansea).—A. Grounds: Preparation of Coal for the Market.

SATURDAY, JANUARY 5.

ROYAL INSTITUTION OF GREAT BRITAIN (at Institution of Electrical Engineers), at 3.—A. Wood: Sound Waves and their Uses (V.): The Ear and What it does (Juvenile Christmas Lectures).

MONDAY, JANUARY 7.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Prof. H. S. Allen: Remarks on Band Spectra.—Dr. I. Sandeman: The Fulcher Bands of Hydrogen.—F. B. Hutt: (a) On the Relation of Fertility in Fowls to the Amount of Testicular Material and Density of Sperm Suspension—Studies on Embryonic Mortality in the Fowl, (b) Part 1. The Frequencies of Various Malpositions of the Chick Embryo and their Significance.—F. B. Hutt and A. W. Greenwood: (a) Part 2. Chondrodystrophy in the Chick; (b) Part 3. Chick Monsters in Relation to Embryonic Mortality.—L. A. Harvey. The Oogenesis of *Carcinus mænas* Penn., with Special Reference to Yolk Formation.—J. Wishart: The Correlation between Product Moments of any Order in Samples from a Normal Population.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Dr. W. Bell Dawson: The Hebrew Calendar and Time Periods.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (in Laboratories of Applied Electricity, Liverpool University), at 7.—W. B. Woodhouse. Overhead Electric Lines.

BRADFORD TEXTILE SOCIETY (at Midland Hotel, Bradford), at 7.30.—A. M. Chapman. The Application of Worsted Yarns to Dress Goods and Coatings.
SOCIETY OF CHEMICAL INDUSTRY (London Section, jointly with the Fuel Section) (at Burlington House), at 8.—J. I. Graham: The Action of Hydrogen upon Coal.
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Dr. O Faber: The Expansion and Contraction of Building Materials due to Temperature, Humidity, Stress, and Plastic Yield.
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8 30.—C H. Karius: The First Crossing from the Fly River to the Sepik, New Guinea.
INSTITUTION OF THE RUBBER INDUSTRY (London Section) (at Blackfriars Theatre, E.C.).—F. W. Bennett: Factory Organisation in the Rubber Industry Affecting the Conditions of the Worker.

TUESDAY, JANUARY 8.

ROYAL INSTITUTION OF GREAT BRITAIN (at Institution of Electrical Engineers), at 3.—A. Wood: Sound Waves and their Uses (VI.): How Sounds are Recorded and Reproduced (Juvenile Christmas Lectures).
INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 5.30.
ROYAL SANITARY INSTITUTE, at 5.30.—Prof. A. Bostock Hill and others: Discussion on Cleanliness. Is it the Basis of Health?
INSTITUTION OF CIVIL ENGINEERS, at 6.
INSTITUTE OF MARINE ENGINEERS, at 6.30.—J. Calderwood: The Diesel Engine for Passenger Ships and Fast Cargo Liners.
INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—J. L. Carr: Recent Developments in Electricity Meters, with particular reference to those for special purposes.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—A H. Blake: London through the Eyes of Hogarth.
BURNLEY TEXTILE SOCIETY (at Mechanics' Institute, Burnley), at 7 15 —H. C. Barnes Conditions in Cotton Manufacturing Abroad.
INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—W. T. Butterwick and others: Informal Discussion on Shipbuilding.
QUEKETT MICROSCOPICAL CLUB, at 7.30.—W. N. Edwards: Microscopical Study of Fossil Plants.
INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.45.—Dr. F. W. Lanchester: Coil Ignition
HULL CHEMICAL AND ENGINEERING SOCIETY (Grey Street, Hull), at 7.45.—G. R. Adamson and C. F. Tinker: Electric Cranes.
ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 8.30.—Discussion: The Use of Artificial Sunlight in Mental Hospitals.
PHARMACEUTICAL SOCIETY OF GREAT BRITAIN (North Metropolitan Branch) (at 17 Bloomsbury Square), at 9.—G. Fletcher: Ireland: Its Scenery and People.

WEDNESDAY, JANUARY 9.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. O. T. Jones: The History of the Yellowstone Cañon, Yellowstone National Park, U.S.A. (Lecture).
INSTITUTE OF METALS (Swansea Local Section) (at Thomas Café, Swansea), at 7.—G. E. K. Blythe: Pulverised Coal in Metallurgy.
INSTITUTE OF FUEL.—H. A. S Gothard: The Application of Pulverised Fuel Firing for Lancashire Boilers.

THURSDAY, JANUARY 10.

ROYAL SOCIETY OF ARTS, at 3.—Capt. Sir Arthur Clarke: Ships and Lighthouses (Dr Mann Juvenile Lectures) (II.).
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Capt. J. M. Donaldson, Capt. J. G. Hines, and others: General Discussion on A Study of the Future Development of Demand and the Economic Selection, Provision, and Layout of Plant, as illustrated by Telephone Systems on the one hand and Power Systems on the other.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Colour Group), at 7.—F. R Newens: Demonstration of Flashlight in Colour Photography and the Desensitising and Development of the Agfa Colour Plate.
LITTLEBOROUGH TEXTILE SOCIETY (at Central Council School, Littleborough), at 7.30 —H. Sutcliffe: Some Power Transmission Problems.
INSTITUTE OF METALS (London Local Section) (at 83 Pall Mall), at 7.30.—H. C Lancaster: The Lead Industry.
OIL AND COLOUR CHEMISTS' ASSOCIATION (30 Russell Square), at 7.30.—B. Campbell: Nitro-cellulose Lacquers.
INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Branch).
INSTITUTE OF CHEMISTRY (Manchester Section) (at Manchester).—H. D. K. Drew: Pregl's Micro-methods of Analysis.

FRIDAY, JANUARY 11.

ROYAL ASTRONOMICAL SOCIETY, at 5.
PHILOLOGICAL SOCIETY (at University College), at 5.30.—L. C. Wharton: Dialect Developments.
MALACOLOGICAL SOCIETY OF LONDON (in Zoological Department, University College), at 6.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in Mining Institute, Newcastle-upon-Tyne), at 6 —W. J. Drummond: Coal used in its Raw State.—Dr. W. T. K. Braunholz: Fuels obtained by the Treatment of Coal.
INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—J. A. H. Lloyd: Telephone Repeaters.
BLACKBURN TEXTILE SOCIETY (at Blackburn Technical College), at 7.30.—Dr. P. Bean: The Dyeing of Artificial Silk.
KEIGHLEY TEXTILE SOCIETY (at Kiosk Café, Keighley), at 7.30 —Lecture on Artificial Silk.
OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Milton Hall, Manchester), at 7.30 —Dr J. J. Fox: The Examination of Paints.
SOCIETY OF CHEMICAL INDUSTRY (Manchester Section).—N. S. Humphries: The Efficiency of the Present-day Finishing Stenter.
SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group).—Prof. B. P. Haigh: The Relative Safeties of Mild and High-Tensile Alloyed Steels under Alternating and Pulsating Stresses.

EXHIBITION.

TUESDAY, WEDNESDAY, AND THURSDAY, JANUARY 8, 9, AND 10.

PHYSICAL SOCIETY AND OPTICAL SOCIETY (at Imperial College of Science).—Exhibition of Scientific Instruments.—Discourses during the Exhibition, at 8 each evening:—
On Jan. 8.—Prof. F. Lloyd Hopwood: Experiments with High Frequency Sound Waves.
On Jan. 9.—C. Beck: Lenses.
On Jan. 10.—A. J. Bull: Some Colour Problems in Photo-Engraving.

PUBLIC LECTURE.

TUESDAY, JANUARY 8.

UNIVERSITY OF LEEDS (in Philosophical Hall, Leeds), at 6.—O. E. Simmonds: The Wonders of Flying.

CONGRESSES.

JANUARY 4.

CONFERENCE OF EDUCATIONAL ASSOCIATIONS (at University College).
Friday, Jan 4, at 11 A.M.—British Broadcasting Corporation.—Demonstration of Educational Broadcasting.
At 2 30.—Medical Officers of Schools Association.—Dr. A. A. Mumford: Physical Activity and Physical Training in Relation to Scholastic and University Progress.

JANUARY 4 AND 5.

GEOGRAPHICAL ASSOCIATION (at London School of Economics).
Friday, Jan. 4, at 10 A.M.—E. J. Orford and others: Discussion on Educational Re-organisation and the Teaching of Geography.
At 11.45 A.M.—Sir H. G. Lyons: The Geographer and his Material (Presidential Address).
At 2.30.—Prof. C. B. Fawcett: The Balance of Urban and Rural Populations.
Saturday, Jan. 5, at 10.30 A.M.—Dr. Vaughan Cornish: On Linguistic Frontiers in Central Europe dating from Heathen Times.
At 11.45 A.M.—Hon. Secretary: Summary of the Results of Discussions held on the previous days.

JANUARY 4 AND 5.

NORTH OF ENGLAND EDUCATION CONFERENCE (at Heaton Secondary Schools, Newcastle-upon-Tyne).
Friday, Jan 4, at 10 A.M.—A. R. Pickles and others: Free Place Examinations.
At 11.15 A.M.—Miss L. Jowitt and others: Social Activities in Education.
At 2 45.—A. Watson and others: Education in Relation to Industry and Commerce.
Saturday, Jan. 5, at 10 A.M.—F. A. Hoare and others: The League of Nations and the Schools.

JANUARY 7 AND 8.

MATHEMATICAL ASSOCIATION (Annual Meeting) (at London Day Training College).
Monday, Jan. 7.
At 4.—H. G. Forder: The Axioms of Geometry.
At 5.30.—Prof. H. M. Levy Modern Mathematical Problems in Aerodynamics.
Tuesday, Jan. 8.
At 10 A.M.—Miss E. R. Gwatkin and others: Discussion on Should a Candidate for School Certificate be allowed to take, in place of the Mathematics and Science Group, a Group containing Drawing and Music and possibly other Subjects?
At 11.45.—N. J. Chignell: The Use and Abuse of Formulæ.
At 2.30.—Dr. W. F. Sheppard: Variety of Method in the Teaching of Arithmetic.
At 3 45.—Prof. J. E. A. Steggall: Methods of Voting in Theory and in Practice.

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NATURE

SATURDAY, JANUARY 12, 1928.

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Mr. Ormsby-Gore and Tropical Development.

THE attributes of a true research worker are high intellectual endowment, a desire for knowledge, a capacity for accurate observation and selection of relevant facts and data, a mind unbiased by preconceived ideas, sound judgment, and breadth of vision. We rarely associate such a combination of qualities with our politicians. Special pleading is the enemy of truth. Occasionally, however, even a politician may free himself from the shackles of political expediency, and put the general interest before self-interest, mankind before country, and country before party. To distil the essential wisdom from the heterogeneous ingredients of party controversy requires the courage of statesmanship, the penalty of which is not infrequently loss of office and political oblivion. For office is a party spoil.

These reflections savour of the platitudinous, but they are occasioned by reading the remarkable report (Cmd. 3235; London: H.M. Stationery Office) on his visit to Malaya, Ceylon, and Java, which the Parliamentary Under-Secretary of State for the Colonies, Mr. Ormsby-Gore, has just completed for presentation to Parliament. This is the fourth report of its kind, based on personal visits, for which Mr. Ormsby-Gore has been partly or solely responsible. In 1922 he accompanied his predecessor in office (Mr. Edward Wood, now Lord Irwin) to the West Indies and British Guiana. Two years later, Mr. J. H. Thomas, then Colonial Secretary, made him chairman of the Parliamentary Commission which visited East and Central Africa, and in 1926 he made a tour of the four British Colonies in West Africa. In the course of these tours alone, therefore, he has formed direct personal contact with the most of the dependencies the affairs of which fall within the scope of his ministerial responsibility. His personal acquaintance with the countries of the Empire does not end there, however. Before the War he visited South Africa and Rhodesia, and during the War he served in Egypt, later as intelligence officer in the Arab Bureau, and finally as Assistant Political Officer in Palestine. Probably no other minister has been able to bring to bear upon his task such comprehensive first-hand acquaintance with our non-self-governing dependencies and the mandated territories for which we are responsible.

Had such tours been made solely with the object of obtaining first-hand information for facilitating Mr. Ormsby-Gore's own work at the Colonial

Office, they would have been amply justified. Fortunately, he has a wider conception of his responsibilities. The knowledge he has gained he puts at the disposal of us all. He tells us freely what opinions he has formed, what modifications in policy he would advise. He gives us facts with strict impartiality. He expresses his opinions with no attempt at dexterous ambiguity, and certainly with no air of infallibility. On the contrary, he invites criticism, having first provided us with the necessary knowledge upon which to base it. These are the methods of the research worker, the methods which make for progress. They are certainly the only methods which will ensure that colonial development will proceed on right lines.

In each successive report on British colonies, Mr. Ormsby-Gore has advanced his claim to be considered a research worker, not, it is true, as an original investigator in a specialised branch of science, but in the wide and complex fields of human relationships and the relation of man to his environment. In these four reports on the colonies are set out with admirable clarity, completeness, and in due perspective, the multiplicity of problems confronting our colonial governments, together with what has been done towards their solution and what still remains to be done, what could have been done had our existing knowledge been properly brought to bear upon them, and problems which are likely to make the greatest demands on our research workers. Considered as a comprehensive whole, these reports constitute a great achievement. They can, with sincerity and truth, be described as a monumental and magnificent research.

In the introduction to his report on Malaya, Ceylon, and Java, the occasion of this review, Mr. Ormsby-Gore reminds us that "British possessions in the tropics are at widely different stages of development, but each and all have many problems in common, and each has something to learn from the experience and practice of others." Accordingly, in this, as in previous reports, he concentrates on particular features; for example, the state of agriculture and animal husbandry, public health, education, forestry, and transport, hoping that their study by the comparative method may reveal facts and suggestions which may prove useful to other colonies. A separate chapter is devoted to rubber; first, because it is the principal economic crop of Malaya; and, secondly, to comment on the results of the Stevenson scheme of restriction of output of this commodity. All these subjects possess a special interest for scientific workers, and in dealing with each of them Mr. Ormsby-Gore lays stress on the contributions which science has made or can be expected to make to the development of the services or industries with which they are related.

Not the least valuable parts of the report are those dealing with geographical, historical, and economic facts relating to the colonies. They cannot fail to interest anyone with the slightest desire for knowledge of conditions of tropical life. They are presented also in such a way as to fix outstanding facts in our minds. British Malaya, we are told, covers a total area a little less than that of England. Its total population is to-day probably about four millions. The Dutch Colony of Java, climatically resembling British Malaya, covering a smaller area, contains a slightly larger population than England, although most of the Javanese (the Handbook of the Netherlands East Indies gives the proportion as more than 70 per cent) are engaged in farming. Practically the whole of Java is under cultivation, whereas the greater part of the Malay peninsula is still virgin forest, and a large proportion of the food supplies for its inhabitants has to be imported. Yet, although the population density of Java is eleven times, and its actual population nearly ten times, that of British Malaya, its overseas trade is less than that of the British colony. For 1926 the imports of British Malaya were valued at £117,000,000, and the overseas exports at £147,000,000, the corresponding figures for Java being £72,000,000 and £131,000,000, all figures being exclusive of bullion and specie. "These remarkable totals [for British Malaya] exceed those of the total external trade of the whole of the rest of the Colonial dependencies put together. The value of exports per head of the population of British Malaya for the last two years has exceeded that of any other country in the world, and is higher even than the figure for New Zealand, which leads the self-governing Dominions in this respect."

Tin and rubber are the two factors determining this result for Malaya. "In 1927 nearly half the world's tin supply was mined in Malaya, and about 70 per cent of the supply of refined tin was shipped from the smelting works in Singapore and Penang." The net export of crude plantation rubber from Malaya in 1927 was 240,000 tons, representing more than 42 per cent of the total exports of rubber-producing countries. Soil fertility is the main factor determining the high population density of Java. The mountain region in Java consists entirely of volcanic rocks which disintegrate

rapidly in the warm, humid climate, and thereby enrich the soil. There are other contributory factors to be taken into account. The pirates of the Straits may have for centuries deflected Indian and Arab traders and settlers from Malaya to Java, while the efficiency of the Dutch colonial scientific and technical services in Java has resulted in vastly increased yields per acre and facilitated population increase. "The island of Java," says Mr. Ormsby-Gore, "affords the most remarkable example in the world to-day of the application of science to the development of the tropics." Obviously, neither piracy nor science can have been of great importance in comparison with the natural fertility of the soil in the determination of Java's high population density. If they had been, we should expect Sumatra to have a much higher density of population than British Malaya, whereas it is only slightly higher.

Nevertheless, what the Dutch have accomplished in Java by the application of science should provide much food for thought for all our colonial governments, and even India. The yield of rice per acre in Java is a little more than double that of British India. Last year (1928) Java expected to produce nearly three million tons of sugar from less than half a million acres of land. Since the establishment of the sugar industry in Java, about the middle of the last century, the yield per acre has been increased sixfold. Java is now the highest sugar producer per acre in the world, and owes its position to the application of plant genetics and soil science. The success of the cinchona (quinine) industry, a virtual monopoly in which is held by Java and Sumatra, has been due almost entirely to very strict scientific controls. The problems presented to the Irrigation Department in Java are some of the most difficult that have ever been presented to hydraulic engineers, Mr. Ormsby-Gore informs us, but they appear to have solved most of them. "As an investment it [the Irrigation Department] has repaid the Dutch East Indies very handsomely, and assuredly it is an outstanding example of the benefits which western science and technical skill can offer." In Buitenzorg, in Java, there are the famous tropical plant research station and a number of other institutions with which more than a hundred scientific workers are associated.

All research for the Dutch East Indies, however, is not centralised in the government research institute at Buitenzorg. The plan of special research institutes, the activities of which are centred in a particular crop, as advocated and put into effect by the Howards in India, has been in existence for a number of years in Java. "The pivot of the sugar industry in Java is the great sugar research-station at Pasoerean in East Java," the finest of its kind in the tropics. It has been supported entirely by the industry from its inception. Six other separate agricultural research stations, "proef-stations" as they are called, are maintained by the "Algemeen handbouw Syndicaat," or General Planters' Association, entirely by private subscription and voluntary levies. There are a Tea Research Station at Buitenzorg, staffed by nine European scientific workers; a Rubber Research Institute, also at Buitenzorg, also with nine workers; a coffee 'proof' station at Malang in East Java with eight; the Besoeki Proof Station at Djember, East Java, for tobacco, rubber, and coffee, with five Europeans; a quinine station at Tjinjiroean, in the Preanger Highlands, West Java; and a small general 'proof' station at Salatiga, near Samarang, Central Java.

Having been given the opportunity to make himself personally acquainted with the work of the Dutch administration and Dutch scientific workers in Java, noting that the greatest advances in the rubber-planting industry have been made by the United States Rubber Plantations and the A.V.R.O.S. Rubber Experimental Station in Sumatra, that Malaya has a handicap of ten years to make up in the scientific study of budgrafting and related problems of the rubber industry, that "the share of Malaya and Ceylon in total world exports of crude plantation rubber has fallen from 70 per cent in 1922 to 52 per cent in 1927, while the Dutch East Indies have increased their share from 25 per cent in 1922 to over 40 per cent in 1927," that "Malaya is behind Java in the use of wireless telegraphy and telephony, and its ordinary telephone system is not nearly so complete or far-reaching," Mr. Ormsby-Gore finds the cause in the British administration services. His attitude is reflected in the following comment on the recruitment of administrative officers for these colonies. "The examination seems still to attract in the main those who have specialised at the University in classics or pure mathematics. In the tropics, especially in tropical areas in process of rapid economic development, sound basic knowledge of natural science, biology as well as physics and chemistry, is of ever-increasing significance. The administrative officer has to fit in and co-operate with a large variety of technical officers, and . . . he should have some idea of the nature of the problems which confront the latter, who often looks upon him as a member of senior and pivotal service."

Neurology and Psychology.

Brain and Mind: or the Nervous System of Man. By Prof. R. J. A. Berry. Pp. xii + 608. (New York: The Macmillan Co., 1928.) 31*s.* 6*d.* net.

IN the opening chapter of this interesting book is introduced the main theme of the whole volume: the neuronic arc is the basis of all nervous activity, whether the simple purposive reflex or even the human cerebral processes associated with thought, memory, and reasoning. Neuronic arcs are formed by chains of neurones or nerve cells functionally connected by synapses. The neurone is therefore the unit of nervous activity. This theme dominates the whole book, and it is in entire agreement with experimental findings.

For more than four hundred pages the morphology and development of the nervous system is dealt with in a systematic manner. Since this part of the book closely resembles most books on the anatomy of the nervous system, there is no need to consider it in detail. We doubt the utility of the continual publication, in books of this type, of much of the detailed anatomy of those parts of the nervous system concerning the function of which we are almost entirely ignorant, for it seems to cause a rather large break in the real matter in hand. There are numerous diagrams, some of which are very illustrative, and also short accounts of the physiology of the various parts described.

Unfortunately, Prof. Berry has not taken sufficient account of the more recent advances in the physiological knowledge of the nervous system. This is particularly evident in his chapter on the nerve impulse, where one finds his use of the term 'nerve energy' very vague and somewhat misleading. With our present conceptions of the physiology of the nervous system, such a term is better not used at all. We notice with approval that the histology of the cerebral cortex is dealt with clearly and fully. Prominence is given to the division by Watson of the cerebral cortex into three layers—infragranular, granular, and supragranular. The infragranular cortex is stated to be the brain of the animal and sexual instincts, the granular of reception and storage of impulses, and the supragranular of control, inhibition, and reason. While Bolton and Watson have adduced much evidence in support of this, we regard it as by no means proved, and, especially in the association areas, it seems possible that all parts of the cortex are concerned in the higher cerebral functions of control and reason. This division of the brain into layers of different function is perhaps no more absolute than the older division of it into functionally distinct areas.

In this and other places it is regrettable that Prof. Berry does not distinguish more clearly between facts and theories. The assignment of the function of 'storage of receptor impulses,' *i.e.* the basis of memory, to the neurones of the granular layer is interesting, but requires experimental support. Prof. Berry does not tell us how this storage occurs, and the idea seems opposed to our physiological knowledge. The usually accepted theory of memory is that a modification in the so-called synaptic resistance is produced by the passage of impulses, and this change may be of long duration if sufficiently intense. This can scarcely be termed a 'storage of impulses.' There are also speculations on the functions of other cells of the cortex. It is interesting to see the correlation of the developmental thickening of the cortex, and especially the myelination of the white matter with the data of Berry and Porteous on the increase in the cerebral capacity of the living child.

In the second part of the volume, Prof. Berry attacks the problem of the correlation of the morphology of the cerebral cortex with psychology. We agree with his insistence that psychology should be considered in relation to the structure of the brain, but we are not convinced that this has been successfully accomplished. For success to be attained, a much more precise knowledge of the detailed structure and function of the cortex is necessary, and that can only be obtained by years of patient research. The work of Pavlov on the cortex is of especial importance, yet it finds but scant mention in this book. Until our physiological knowledge is greatly added to, structure can be of little assistance in the elucidation of psychic processes. The difficulties are brought before us by the obscurities of many of the passages in some parts of this section.

On the psychological side Prof. Berry reminds one somewhat of McDougall, and his criticism of Freud is healthy and stimulating. For the most part it is just sound common-sense correlated with neurological knowledge. There is no doubt that we must agree with Prof. Berry's main theme—no neurone, no mind—and it is also certain that the individual who possesses less than a certain number of cortical neurones cannot be expected to be normal in behaviour. We are not convinced, however, that one can go further than this and say that intelligence is proportional to the number of cortical neurones. As yet, our knowledge of the functioning of the cortical neurones is not precise

enough to allow of anything except vague suggestions regarding their behaviour in mental processes, and, until our knowledge is more profound, mere numerical value is an unknown factor. As Prof. Berry himself states, the data from histological examination of cerebral cortices and from head measurement are only definite in extreme cases. One must bear in mind all those finer gradations in conduction from one neurone to another in the spinal cord, as found by Sherrington and others, and consider the possibility that in the cortex the gradations are even more delicate and more variable. In such a comparatively simple region of the nervous system as the spinal cord, it would be absolutely impossible to form any idea of the peculiarities of the reflexes elicited from it after the most careful macroscopic and microscopic examination. One must realise how crude our technique is. The index of chromatolysis on which the author places emphasis is by no means certain in interpretation. It seems unlikely that Nissl bodies are the source of the so-called nerve energy; most likely they are reserve food in the neurone.

Taking into account all these extreme difficulties, for there is no doubt that the human cerebral cortex is the most difficult problem man will ever face, one cannot help feeling that Prof. Berry has done well to get, in these days, so far as he has. In those interesting series of tests for mentally deficients, he has given us something of real value, for the high-grade ament is a very serious menace to society, and his early detection and control a matter of the greatest moment. The author's large experience of more than 15,000 cases places him in a position to speak authoritatively on that subject. He lays due stress on the fact that, while brain capacity is a useful test, it must only be used as an aid to diagnosis in combination with other tests. It is only after the application of all the tests described by the author that any attempt at diagnosis can be made.

A careful perusal of this part of the book makes one aware of the difficulties of diagnosis which must occur in many cases, and the imperative need for a special training in the subject. The majority of the medical profession are sadly unfamiliar with the diagnostic methods for high-grade amentia. The importance of a diagnosis is stressed by Prof. Berry, for investigations have shown that a large proportion of criminals and other anti-social individuals are made up of high-grade aments. In other high-grade aments there is the development of various neuroses and psychoses due to an incompetent brain being unable to cope with the stresses of modern life. The early diagnosis of high-grade amentia would enable the individual to be brought up in a suitable environment to the advantage both of himself and of the community. We can only wish that medical men, social workers, and educationists were familiar with the problem presented to society by the existence of high-grade amentia, and, above all, with the methods of attacking that problem. We cannot do better than to recommend them to read at least the last few chapters of this interesting book.

A more complete bibliography and more numerous references in the text would be an improvement. Some useful reference tables and a good index complete this attractively published volume.

J. C. ECCLES.

The Works of Roger Bacon.

(1) *Opera hactenus inedita Rogeri Baconi. Fasciculus VI. Compotus Fratris Rogeri, accedunt Compotus Roberti Grossecapitis Lincolniensis Episcopi, Massa Compoti Alexandri de Villa Dei,* nunc primum edidit Robert Steele. Pp. xxviii +302. 1926. *Fasciculus VII. Questiones supra Undecimum Prime Philosophie Aristotelis,* nunc primum edidit Robert Steele collaborante Ferdinand M. Delorme, O.F.M. Pp. xii + 160. 1926. *Fasciculus VIII. Questiones supra libros quatuor Physicorum Aristotelis,* nunc primum edidit Ferdinand M. Delorme O.F.M. collaborante Robert Steele. Pp. xxii + 284. 1928. *Fasciculus IX. De Retardatione Accidentium Senectutis cum aliis opusculis de rebus medicinalibus,* nunc primum ediderunt A. G. Little, E. T. Withington. Pp. xliv + 224. 1928. (Oxford: Clarendon Press; London: Oxford University Press.)

(2) *The Opus Majus of Roger Bacon.* By Roger Bacon. A Translation by Robert Belle Burke. Vol. 1. Pp. xiii + 418 + 4 plates. Vol. 2. Pp. vi + 419-840 + 4 plates. (Philadelphia: University of Philadelphia Press; London: Oxford University Press, 1928.) 42*s.* net.

THERE has recently appeared a whole series of important works on Roger Bacon. Since 1926, four parts of the "Opera hactenus inedita Rogeri Baconi" have been issued from the Clarendon Press, and now an English translation of the "Opus Majus" appears, in two large tomes, from the University of Pennsylvania. The time is approaching when we shall be able to form a balanced judgment of Roger from a survey of all his works. In the meantime we must be content to consider these works separately.

(1) Mr. Robert Steele is responsible, in part or in whole, for three out of the four volumes which the authorities of the Clarendon Press euphemistically describe as 'Fasciculi.' The smallest of these diminutive works contains some 170 closely printed pages. The largest can only be completely studied by those who survive to the three hundred and thirtieth page. 'There were giants in those days.' Something more than ordinary enthusiasm is needed to sustain a man through years of such heroic labour as the preparation of these volumes implies. Mr. Steele has a standing in work of this kind that places him above criticism. We shall content ourselves by placing before the reader some abstract of the results of his labours and of those of his colleagues.

Fasciculus VI. deals with the "Compotus" of Roger. "Compotus" is the science by which time is reckoned. The need of such studies arose from the difficulty of combining a lunar calendar with a solar, since the lunar month and solar year are incommensurable. In the Middle Ages the matter assumed pressing importance, because of the stress laid on the fixation of the dates of the Church festivals, and notably of Easter. A number of works were produced on the subject, among which that of Roger takes an important place. Of it Mr. Steele rightly says that:

"The outstanding merit of this work, written at a time when Bacon was undoubtedly passing through a period of dejection, is that it forms a complete treatise on the calendar; it is a masterly exposition of what was known about the measurement of time at a period when astronomical observation with the naked eye had been pushed to its farthest point, and reduced to tables of great accuracy. It gives also an account of the history of the subject much fuller than is to be found in any of the earlier authors, embodying the knowledge of its time. Lastly, it is in itself a masterly and complete, though tacit, exposition of all the evidence against the assumptions of the ecclesiastical calendar; only towards the end of the treatise, when Bacon has summed up, does he allow himself to give free vent to a criticism where more cautious writers had been silent."

Fasciculus VII. is produced by Father Delorme in collaboration with Mr. Steele. It consists of Roger's lecture notes on the book which we now describe as the twelfth—not eleventh, as Roger calls it—of the "Metaphysica" of Aristotle. A study of it had been incorporated by the late Prof. Duhem in his magnificent treatise, "Le Système du monde." Book XII. of the "Metaphysica" is not of importance for the history of science, and the main interest of Roger's work on it is the evidence that it provides for the sources of his knowledge. It is well known that in his day the chief versions of Aristotle available had been rendered from the Arabic. The book shows, however, that Roger relied also on a very ancient version of Aristotle's "Metaphysica," rendered from the Greek. This is a point of more importance for the history of thought than might at first be supposed.

Fasciculus VIII. is also the joint product of MM. Delorme and Steele, and shows that for the "Physics," as for the "Metaphysics," Roger was using an ancient translation direct from the Greek. The treatise does not increase our estimate of Roger as an exponent of the experimental method, though it is of importance for the history of medieval philosophy. It must be remembered that the "Physics" of Aristotle scarcely deals with that subject as now understood, but with theoretical considerations that received no experimental proof.

Fasciculus IX. is the joint production of Mr. A. G. Little and Dr. Withington, and deals with the medical treatises. It is prefaced by a valuable introduction. There is no doubt of the importance of these treatises to the student of medieval thought, but we look for something higher from Roger. Here is his editor's estimate of these works:

"We must admit that the Epistle and treatises on old age are a grievous disappointment. . . . They show . . . close dependence on authorities he might have known were at best second hand, a simple faith in the marvellous power of remedies, most of which had been used for centuries with no remarkable results, and sometimes a pretence of secret knowledge which reminds us painfully of the alchemic quacks.

"Perhaps the best that can be said is that within twenty years of Roger's death, the greatest physician of the age, Arnald of Villanova, might have been seen diligently perusing one of these treatises, the *Liber de Conservatione Juventutis*, and working it up into another treatise . . . which he then dedicated as an original work to King Robert the Wise of Naples and Jerusalem."

Nevertheless, one of the treatises here printed ("De erroribus medicorum") contains perhaps the most forceful statement that Roger has made as to the nature of the experimental method. It may be translated thus:

"Since science is sure knowledge of truth, and since argument clinches truth but does not exclude doubt, no certitude is produced thereby till experience is added. And anyone finds this to be so in countless matters.

"Thus though the first proposition of Euclid is most powerfully demonstrated when it is said that all lines from the centre to a circumference are

equal, and that each side of a triangle constructed on a given line has that relation to it, and they are therefore equal to one another, the mind of the hearer does not come to rest in the truth till he have experience of the figure of two intersecting circles, with two lines drawn from the point of intersection to the ends of the given line, and not even then does he have absolute assurance unless he goes on to get definite experience by measurement.

"So, however much one should prove by argument to one without experience that a magnet attracts iron, and that such attraction would be possible in Nature, yet the man would never get assurance of it without experience. For we neither care so much for authority nor for reasoning *ad hoc* as for experience, and then the mind comes to rest."

(2) Undoubtedly the most important work of Roger is the "Opus Majus," on which, more than any other, his reputation is based. It is too much to hope—or at least it is too much to believe—that many will read the entire works of Bacon in their original Latin. But, despite modern detraction, Roger does take an important place in the history of philosophy, and it is therefore important that his leading work should be translated into English. Mr. Burke has, on the whole, done his work well. The scientific reader may rely upon the general sense of his version. There are indications that in places he is less acquainted with medieval usage than Mr. Steele and his collaborators in the "Opera hactenus inedita." That standard, however, is a very high one, and the 'book' is, in any event, an extremely useful addition to the library of the history of science.

Roger was a medieval, and his best points are buried in a mass of verbiage. Lest the reader miss his fine statement of the nature of the experimental method, with which he introduces Part VI., we here quote it:

"Having laid down fundamental principles of the wisdom of the Latins so far as they are found in language, mathematics, and optics, I now wish to unfold the principles of experimental science, since without experience nothing can be sufficiently known. For there are two modes of acquiring knowledge, namely, by reasoning and experience. Reasoning draws a conclusion and makes us grant the conclusion, but does not make the conclusion certain, nor does it remove doubt so that the mind may rest on the intuition of truth, unless the mind discovers it by the path of experience; since many have the arguments relating to what can be known, but because they lack experience they neglect the arguments, and neither avoid what is harmful nor follow what is good. For if a man who has never seen fire should prove by adequate reasoning that fire burns and injures things and destroys them, his mind would not be satisfied thereby; nor would he avoid fire until he placed his hand or some combustible substance in the fire, so that he might prove by experience that which reasoning taught. But when he has had actual experience of combustion his mind is made certain and rests in the full light of truth. Therefore reasoning does not suffice, but experience does."

Charles Singer.

Preservation of Animal Remains.

Rezente Wirbeltierleichen und ihre paläobiologische Bedeutung. Von Prof. Dr. Johannes Weigelt. Pp. xvi + 227 + 38 Tafeln. (Leipzig: Max Weg, 1927.) 24 gold marks.

HUGH MILLER, viewing the hundreds of complete fossil fish which lay on a single bedding plane of the Old Red Sandstone, speculated on the causes which had led to so vast an accumulation, and on the repetition of this phenomenon at intervals throughout this series of rocks. The problem he then propounded is still unsolved, and to it have been added those which are presented by the bone beds in the Pontian of Pikermi and in many other horizons and localities.

It is most difficult for any geologist whose experience of the world does not extend beyond western Europe to conceive any conditions under which such masses of dead fish or dead mammals can have been brought together. Even the literature of geology gives little help. Thus Prof. Weigelt's excellent book should prove most stimulating to geologists, and especially to those vertebrate palæontologists who have to determine, as all must for their own satisfaction even if they do not publish their speculations, the conditions under which the animals with whose remains they are dealing lived.

Prof. Weigelt gives an account of all those changes which go on in the body of a vertebrate after death, and explains the events which may produce a carcase like those which are preserved as the Trachodon mummies. He then discusses those causes of death which are likely to affect large numbers of individuals at the same time, or to bring single creatures into positions where their remains have an exceptionally favourable chance of being preserved. He records death through volcanic activity, poisonous gases, prairie and forest fires, drowning, being mired in mud or quicksand, by floods, hunger and thirst, by hunters both human and other, by ice, snow, and mere cold. The last is illustrated by a remarkable case at "Smithers Lake" in south-west Texas. This shallow lake, 1500 acres in extent, is partly artificial, a dam

having caused it to spread over a forested area, killing all the trees; their stumps remain *in situ*, and their twigs and branches are carried about by currents. On Dec. 18, 1924, the air temperature in this locality had a maximum of 80° F. and a minimum of 68° F.; next day the maximum was 68° F. and the minimum 23° F.; whilst on the two succeeding days the temperature never exceeded the freezing point. This frost killed thousands of alligators, tortoises, and gar fish (*Lepidosteus*). In the February and March following the bodies of these animals had been collected into one area by currents and there lay in shallow water, which afterwards dried up. Prof. Weigelt publishes many excellent photographs of these victims which afford most accurate parallels to the appearances shown in fossil ganoid fish.

The numerous plates which illustrate the book will bring vividly before the reader conditions which are familiar to all who have travelled in arid regions but are scarcely appreciated by those who have not enjoyed such an experience.

The book should prove interesting to zoologists in general, as well as to those palæontologists to whom it is specially addressed.

D. M. S. WATSON.

Euclidean Geometry.

The Foundations of Euclidean Geometry. By Henry George Forder. Pp. xii + 349. (Cambridge: At the University Press, 1927.) 25*s*. net.

IT is interesting to compare the attitudes of the two most recent writers in English who deal with Euclidean geometry. Sir Thomas Heath, in the second edition of his three-volume translation of the "Elements" (Cambridge, 1926), reiterates his opinion that Euclid "remains the greatest elementary text-book in mathematics that the world is privileged to possess"; Mr. Forder, in the book under review, emphasises the fact that "many flaws have been noticed in his treatment during the two thousand years that have elapsed since his work was written." The two points of view are, of course, not in the least contradictory. Indeed, Sir Thomas Heath is careful to point out that "much valuable work has been done on the continent in the investigation of the first principles, including the formulation and classification of axioms or postulates which are necessary to make good the deficiencies of Euclid's own explicit postulates and axioms," and not the least valuable part of his great work consists in his notes and commentaries on research on the axiomatic side. Mr. Forder is mainly concerned with foundations, and his book will go far to remove the reproach implied in the words "on the continent" in the passage quoted. Having laid down his foundations, he goes on to erect his edifice of elementary geometry, remarking that "scarcely one proof in any school-text will survive a critical examination." Sir Thomas Heath would probably agree (cf. his original preface, loc. cit., vol. 1, pp. v-vi).

It is somewhat remarkable that no one before had written a "connected and rigorous" account of Euclidean geometry comparable with Veblen and Young on projective geometry; the gap needed filling up, and Mr. Forder has done it admirably. Naturally, the result makes somewhat heavy reading, and the temptation to ignore the advice "to make sure that the full formal proof can be given" in each case is very strong. Still, the numerous 'notes,' in smaller type and less formal phraseology, help to lighten the way along.

We begin with axioms of order, a three-termed relation between points, and work up to definitions of the line, the plane, and the space. (In parenthesis, may we ask whether it was really necessary to introduce the horrible verbs 'to colline' and 'to coplane,' and to abbreviate 'Theorems' into 'Thes.'?) The next chapter uses these axioms to develop theorems on angles and order relations between rays from the same point. Then come axioms of congruence. It is interesting to compare the author's blunt dismissal of the method of superposition, "this vicious method" (p. 91), with Sir Thomas Heath's more courteous historical treatment (loc. cit., vol. 1, pp. 225 ff.). We are next given applications to the properties of circles and spheres which do not depend on the parallel axiom; a new axiom concerning the intersection of two circles is necessary, and this in turn enables us to drop certain of the congruence axioms previously used.

Chap. vi. deals with parallel axioms, which distinguish Euclidean geometry from other geometries with congruence theories; various forms, differing in strength, are given and discussed, with applications to parallelograms and a digression on projective geometry. The author then proceeds, on the basis laid down, to develop a theory of proportion, to prove Pythagoras's theorem in a form in which there is no question of areas, to introduce co-ordinates and to consider constructions possible with ruler and compasses, with some reference to Mascheroni's constructions with compasses alone. Still continuing on the same basis, we study the dissection of polygons into triangles,

and so are led to the areas of polygons and the volumes of polyhedra.

In Chap. xiii. a return is made to axiomatics; an axiom of continuity is added, and it is shown how this enables us either to drop the congruence axioms or else to weaken the parallel axiom and drop some of the congruence axioms; both schemes suffice for Euclidean geometry and are consistent and complete. By way of appendix we are given an outline of a different method of procedure in which congruence is taken as the only undefined relation between points, and finally an excursus on non-Euclidean geometries.

We congratulate the author and the Cambridge University Press on an excellent piece of work.

Our Bookshelf.

(1) *Bolles Lee's Microtomist's Vade-Mecum: a Handbook of the Methods of Microscopic Anatomy.* Ninth edition, edited by Prof. J. Brontë Gatenby and Dr. E. V. Cowdry. With the collaboration of Dr. W. R. G. Atkins, the late Prof. Sir William Bayliss, J. Thornton Carter, Dr. Robert Chambers, Dr. W. Cramer, the late Dr. C. de Fano, Dr. Helen Pixell-Goodrich, Dr. J. G. Greenfield, Dr. Reginald Ludford, G. Payling Wright, and Dr. F. W. Rogers Brambell. Pp. x + 714. (London: J. and A. Churchill, 1928.) 30*s.* net.

(2) *Histological Technique: a Guide for Use in a Laboratory Course in Histology.* By Dr. B. F. Kingsbury and Dr. O. A. Johannsen. Pp. vii + 142. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1927.) 11*s.* net.

(1) THE new edition of this indispensable work has been enlarged, new sections have been added, some of the older matter has been omitted, and the names of new collaborators appear on the title-page. Full accounts are given of the technique of tissue cultivation and of micro-manipulation.

More care in editing would remove a few inconsistencies we have noticed. Thus a method for ripening hæmatoxylin solutions is described as having been "re-invented lately," the reference given being dated '1912.' Both the spellings 'methylen-' and 'methylene-' blue occur in text and index; in the latter they are separated, and the pages referred to are for the most part distinct. In fact, the all-important index would be the better for drastic revision, for as it stands it may be necessary to look up several headings to obtain the whole of the information on a particular subject. A good instance of this is 'Acid Fuchsin.' For full information on the uses of this dye several other headings must be consulted (*e.g.* Fuchsin, Acid; Säurefuchsin; Rubin S., etc.), as the page references given under each are for the most part different; *i.e.* they are not cross-references.

(2) The second book is essentially a guide to the fundamental methods of normal and pathological histology as required by the medical and the biological student. Fixation, sectioning, staining and mounting, the microscope, and special methods for blood, muscle, nerve, etc., are all dealt with, and a final section gives methods for the investigation of invertebrates in general. The information appears to be adequate and accurate, and the book should serve the purpose for which it has been written.

R. T. H.

The Potato: its History, Varieties, Culture and Diseases. By Thomas P. MacIntosh. Pp. xvi + 264 + 11 plates. (London and Edinburgh: Gurney and Jackson, 1927.) 12*s.* 6*d.* net.

POTATOES constitute one of the few foodstuffs in which Great Britain is still self-supporting, and great advances have been made in recent years on various problems relating to their culture. The growing menace of disease has directed attention to the classification and identification of the many varieties used in commerce, and, more recently, work in virus disease indicates a reason for the well-known degeneration of stocks. Questions of marketing and synonymous nomenclature are purposely omitted from this volume, but historical notes on the chief breeders and the varieties introduced by them are included.

Perhaps more than with any other crop, it is essential for all workers with potatoes, from whatever aspect, to have a thorough knowledge of the many varieties, and special attention is therefore devoted to their classification and to details of intervarietal differences. These are based on type varieties of the main groups, and the variations in different parts of the plant are clearly and comprehensively set forth and illustrated. The tubers are classified in tabular form, based primarily on colour.

Under modern methods of cultivation, potatoes are usually grown between two cereal crops to gain the full benefit of their cleaning value, and they are the best of all crops in their response to artificial fertilisers. As food they are chiefly valued for their high carbohydrate content, the proteins usually being ignored, but care is needed if they are fed uncooked to livestock. Industrially, they are widely used for alcohol production (giving a residual cattle food), potato starch and flour, dextrine, glucose, and for dried potatoes. The danger of attack by plant and animal pests is naturally great in such a universally grown crop, and virus, fungus, and bacterial diseases call for the utmost efforts of pathological research workers. Descriptive notes of some common commercial varieties, and a glossary of the more technical terms, conclude this most useful summing-up of modern work on potatoes.

The Fundamentals of Chemical Thermodynamics. By Dr. J. A. V. Butler. Part 1: *Elementary Theory and Applications.* Pp. xi + 207. (London: Macmillan and Co., Ltd., 1928.) 6*s.*

THE author believes that the student of chemistry should become acquainted with thermodynamical methods at an early stage, and his book affords an elementary introduction to the underlying

principles and their applications. It demands little mathematical equipment and is chiefly concerned with cyclic processes. All the nine chapters conclude with numerical examples to which, however, no answers are provided. Nearly half the book deals with the applications of thermodynamics to electrochemistry, and in some cases the material has little relation to thermodynamics. It is regrettable that the symbol δ has been used in place of the correct notation for partial differentiation. On p. 39 the transition point of rhombic to monoclinic sulphur is given as 95·5° C. in the text and 96·5° C. in the figure. In the consideration of gaseous reactions in Chapter v., the law of mass action is deduced by using two equilibrium boxes. This method of deduction does not correspond with any practical case and a better method is that used a few pages later for the maximum work, in which the problem is again worked out in detail and the external work term is introduced. The book is clearly and carefully written, well printed, and is reasonably priced. A second volume dealing with thermodynamical functions is promised.

Some Questions of Musical Theory. Chapter 3: The Second String; Chapter 4: Ptolemy's Tetrachords; With an Appendix: The Tierce-tone Scale. By Dr. Wilfrid Perrett. Pp. iv + 31-98. (Cambridge: W. Heffer and Sons, Ltd., 1928.) 5*s.* net.

THIS is a continuation of the author's preceding chapters, "How Olympos found his New Scale" and "The Olympion," published in 1926. The first of the new chapters is a technical and historical discussion of the problem of the second string of the enharmonic tetrachord, and Dr. Perrett directs attention to the fundamental difference between the ancient and the modern practice of harmony, the Greeks apparently having no instruments constructed to give very deep notes, and the singers forming their chorus being men, whose vocal enharmonic would have to be written in our bass clef. The orchestration, mainly for harps and clarinets, must have been a light one, lying mainly above the voice part—more like what we should call an obligato.

The second chapter gives a careful analysis of the tetrachords of Ptolemy and their relation to the Tablature. Attention is naturally directed to the way in which we, accustomed to the Lydian mode, think of *the* scale as an uninterrupted series of eight notes, whereas the Greek musician looked upon the octave as composed of two descending series of four notes, two tetrachords separated by a "tone of disjunction." This view of the octave is still held in the Greek Church. H. D. A.

Myths and Legends of the Polynesians. By Johannes C. Andersen. Pp. 512 + 48 plates. (London, Bombay and Sydney: George G. Harrap and Co., Ltd., 1928.) 21*s.* net.

IN his preface Mr. Andersen admits that in the field of Polynesian mythology his personal gleaning has been small. He came too late in the field. He has accordingly availed himself freely of the work of Grey, of Percy Smith, and particularly of Elsdon Best, to name some only of those to whom he makes full acknowledgment. His own contribution to this survey is a running commentary and an abstract of legends not cited in full, which makes his book a survey of and guide to Polynesian tradition, culture, and belief. It is prefaced by a few general remarks on the physical character and languages and present conditions of the Polynesian which, brief as they are, give some background for the main theme of the book.

The traditions of Polynesian migration receive due attention, as do the creation legends and those in which Maui figures. The non-specialist public, for whom presumably the book was written, will find in its stories much that is beautiful as well as strange, while the folklorist whose interest is general rather than specifically centred on Polynesia will appreciate its value as a guide to original sources of information.

Progressive Trigonometry. Part 1: *Numerical Trigonometry and Mensuration.* By Frederick G. W. Brown. Pp. x + 222. (London: Macmillan and Co., Ltd., 1928.) 3*s.* 6*d.*

A PREVIOUS work of this author, "Higher Mathematics for Students of Engineering and Science," has already been favourably reviewed in these columns, and the present volume will supply a real want in the introduction of trigonometry at an early stage of the mathematical course. Mensuration is naturally dealt with more fully than when this subject is merely included in a text-book on arithmetic. The simple solution of a triangle is well treated. Throughout there are numerous examples of an interesting and practical character. In the last chapter mention is made of spherical triangles.

The book covers the syllabuses in mensuration and numerical trigonometry of most school examining bodies, and a second part is in preparation which will deal with the trigonometry required to the end of a school course. The whole should prove very useful.

Geology Manual: an Instruction and Laboratory Manual for Beginners. By Prof. Richard M. Field. Part 1: *Physical Geology.* Second edition. Pp. ix + 149. (Princeton: Princeton University Press; London: Oxford University Press, 1927.) 12*s.* 6*d.* net.

THE call for a second edition of this book within a year indicates that at least in the United States it has fulfilled a useful purpose. Practical courses in geology in the universities of Great Britain probably stand less in need of such external assistance, but most teachers will find that they can adopt some of the Princeton methods with advantage.

The new edition is enriched with sections on the chemistry of rock-minerals and the essential characters of the sedimentary rocks, and there is a brief introduction to the study of economic geology. The part of the book which deals with the interpretation of maps remains, as before, the best, though its appeal is necessarily to North America, except as regards the method of treatment.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Transmission of Ultra-violet Light through Tracing Cloth.

DURING an investigation of the effects of ultra-violet light on various types of blue print paper, it was found that ultra-violet light from a quartz mercury vapour lamp passed through ordinary commercial tracing cloth (or linen) to an extent both unexpected and surprising. A number of tracing cloths were obtained, and spectrograms were taken with three seconds exposure using a Hilger quartz spectrograph. Specimens of various types of paper were also tested in a similar manner, and the results are shown in the photographs reproduced (Fig. 1), and in the accompanying tables.

TRACING CLOTHS.

No.	Type of Screen	Approximate thickness in mm	Mesh count per cm.	U.-V Limit in Ångstrom units
	None	..	..	2225
A	Excelsior	0·070	44 × 44	2535 (faint)
B	Imperial	0·070	47 × 47	2535
C	Excelsior	0·083	47 × 47	2535 (faint)
D	Imperial	0·081	43 × 43	2482
E	Lion	0·080	41 × 41	2482

PAPERS.

No.	Type of Screen.	Approximate thickness in mm	U.-V. Limit in Ångstrom units.
	None	..	2225
P	Newspaper	0·070	3984
Q	Kraft paper	0·101	4339 (faint)
R	Wrapping paper	0·077	3125
S	Writing paper	0·069	3125

Thickness and the number of meshes to the centimetre do not seem to have much importance; the material itself seems to be translucent to ultra-violet

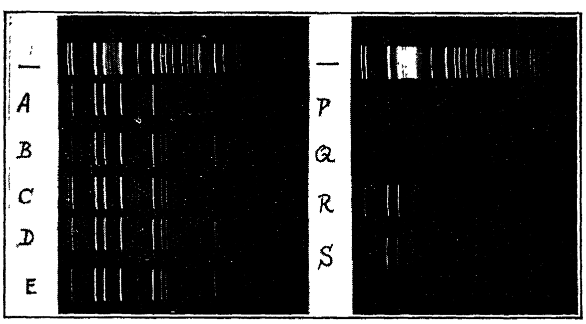

FIG. 1.

light. On the other hand, experiments made with thermopile and galvanometer showed that the heat from the sun or from a red-hot ball passed through the tracing cloth to a much less extent than through glass or vita glass.

Herein may lie the usefulness of this discovery, because, whether in sunlight or in artificial ultra-violet light, it is now possible to screen off much of the heat and yet retain most of the ultra-violet. A single layer of tracing cloth, between wide-meshed wire screens, can now replace curtains or blinds, and with this screen before an *open* sunny window it is possible to enjoy the advantages of ultra-violet light without undue heat or glare, although the eyes should be protected. Moreover, for country cottages, chicken farms, etc., it is now possible to obtain a cheap and effective substitute for the many glasses which have been manufactured to secure ultra-violet light in the more beneficial regions of the spectrum.

C. H. YOUNG.

McGill University,
Montreal, Nov. 22.

A New Band System of Carbon Monoxide.

IN an attempt to photograph the so-called spurious bands associated with the third positive carbon bands, on a 21-ft. concave grating, my plates showed a band at λ3893·2 which was completely resolved under the dispersion. I could also see some bands at λλ3681·1, 4125·0, and 4380·3. Good plates of these bands were obtained in the first order of the grating. The band at λ3681·1 is completely mixed up with one of the spurious bands beginning at about λ3694, and those at λλ4125·0 and 4380·3 are to a more or less extent similarly mixed up with the Ångström bands at λλ4123 and 4393 respectively. On the other hand, the band at λ3893·2 is completely isolated. The fine structure analysis of this band was therefore easily achieved. It has been possible also to analyse the fine structure of the bands at λλ4125·0 and 4380·3, since the structure of the superimposed Ångström bands is definitely known. No attempt has yet been made to analyse the band at λ3681·1 as the structure of the spurious band superposing it is not known.

It has been possible to arrange these bands as follows:

n' \ n''	0	1	2	3
0	27158 0 (H) (3681·1) 27165·5 (*o*)[1]	25678·7 (H) (3893·2) 25686·2 (*o*)	24235·6 (H) (4125·0) 24243·1 (*o*)	22823·4 (H) (4380·3) 22830·8 (*o*)

[1] Calculated.

The final state is thus identical with that of the Ångstrom bands. Fine structure analysis proves the correctness of this arrangement, the (0 − 1), (0 − 2), and (0 − 3) bands having identical $F''(j+1) - F''(j)$ values with those for the respectively similar Ångstrom bands.

Each band consists of one P, one R, and one Q branch, the latter being about twice as strong as either of the other two. One R line and one Q line are missing, and the transition is clearly ${}^1S \longrightarrow {}^1P$, the latter level being identical with that of the Ångstrom system. The initial level is about $5000\,\nu$ higher up than the initial level of the Ångstrom bands, and is thus identical with the new level at $91923\,\nu$ recorded by Birge (*Phys. Rev.*, **29**, 922; 1927). The new level is clearly shown by the present bands to be an ${}^1S$ level, and therefore the bands are very probably due to the transition $3{}^1S \longrightarrow 2{}^1P$, if the Ångstrom bands are $2{}^1S \longrightarrow 2{}^1P$.

The fact that the new system has only one n'' progression is noteworthy. The Ångstrom system has the $n' = 0$ progression well pronounced, but in addition possesses the first two members of the $n' = 1$ progression. The third positive carbon bands and the

3*A* bands are also remarkable this way. The critical potential of the new bands is 0·62 volt higher than that of the Ångstrom bands, and is thus about 0·2 volt higher than that of the 3*A* bands. Hence it is not surprising that they consist of only the $n' = 0$ progression.

The vibrational perturbation peculiar to the (0 – 0) and (1 – 0) Ångström bands seems to be also present in these bands. Though this is fairly certain, since the band at λ3681·1 is not analysed, this statement is only tentative.

It appears possible to identify with the above bands those recorded by Duffendack and Fox (*Astrophys. J.*, **65**, 220; 1927). The three bands recorded by them as associated with the Ångström bands are λλ3679·5, 3894·8, and 4380·1. I feel justified in saying that these are the three of the four bands discussed in this letter. If I am correct, the 'legitimate' objection raised by them to the present analysis of the Ångström bands obviously disappears. Deslandres' band at λ3893, which Wolter could not obtain (*Z. wiss. Phot.*, **9**, 361; 1911), is undoubtedly the band at λ3893·2.

I hope to publish a detailed account of this band system elsewhere. My sincere thanks are due to Dr. R. C. Johnson for helpful discussion.

RANGA K. ASUNDI.

Wheatstone Laboratory,
King's College, Nov. 19.

Striations in High Frequency Discharges.

IN the course of an investigation on the starting and maintenance potentials of the luminous column in argon, produced by applying a high frequency potential of wave-length from 10 to 300 metres to external sleeve electrodes, we found that steady striations were frequently developed. Using the method described by Townsend and Donaldson (*Phil. Mag.*, January 1928), an attempt was made to measure the potential fall over single striations to see whether any definite value could be assigned to it.

Steady striations have been observed at pressures ranging from the lowest pressure at which a discharge is obtainable to a pressure of about 10 mm. The most usual appearance of the striated discharge is that shown in Fig. 1. Fig. 2 shows the discharge in argon at the same pressure as in Fig. 1, but for a smaller distance between the electrodes. The luminous portions of the discharge sometimes have dark portions in the middle, giving them the dumb-bell appearance shown in Figs. 3 and 4. At pressures below 1/10 mm. the luminous portions become egg-shaped and have a clearly defined outline, as shown by the luminous portions at the ends of the discharge in Fig. 4. Fig. 5 is a photograph of the discharge under the same conditions as in Fig. 4, except that the distance between the electrodes is increased. The central part of the discharge has become a uniform glow, but a dark space can just be seen at each end of this glow, indicating that two more striations would have appeared had the electrodes been moved a little farther apart.

FIG. 1.—Pressure, 0·4 mm.; diameter of tube, 2·9 cm.; distance between electrodes, 11·5 cm.; λ=80 metres.

FIG. 2.—Pressure, 0 4 mm.; diameter of tube, 2·9 cm.; distance between electrodes, 6 cm.; λ=80 metres.

Striations have been obtained in discharges in argon in pyrex tubes 1·6 cm., 2·9 cm., and 3·9 cm. diameter for oscillations of wave-lengths 11, 40, 80, 160, and 320 metres. They are more easily produced when the longer wave-lengths and narrower discharge tubes are used. The distance between the electrodes when a given number of striations appear in the discharge is less in a narrow tube than in a wide one, as in the striated positive column of a continuous discharge. The lengths of the luminous portions increase as the pressure is lowered, and at low pressures each luminous portion gives rise to two egg-shaped striations. There are certain distances between the electrodes for which a whole number of striations is included, and the dark spaces are then very distinct. For intermediate distances which do not correspond to a whole number of striations, the dark spaces become almost indistinguishable and the luminous column almost uniform.

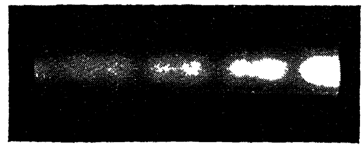

FIG. 3.—Pressure, 0·1 mm.; diameter of tube, 2 9 cm.; distance between electrodes, 17·4 cm.; λ=80 metres.

When the potential difference between the sleeves is gradually decreased, and the minimum maintenance potential is approached, the glow usually becomes uniform. When the luminous column has the striated form, the potential required to maintain it is greater than when the glow is uniform. The striated form occurs more generally in argon than in helium and neon.

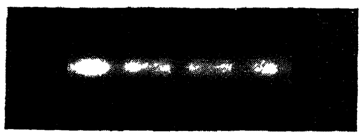

FIG. 4.—Pressure, 0 1 mm; diameter of tube, 1·6 cm.; distance between electrodes, 10 5 cm.; λ=80 metres.

Heidemann (*Ann. der Physik*, Band 85, Nr. 6, 1928) has recently described experiments on high-frequency discharges in hydrogen and in argon, and records a striated discharge in hydrogen, but not in argon. From measurements that he has taken for internal electrodes in hydrogen, he concludes that the fall of potential per striation is constant under different conditions of pressure, but measurements with external electrodes varied from 15·6 to 18·4 volts. Some preliminary measurements of the fall of potential per striation in argon, using external electrodes, were made, and the values of the potentials obtained varied from 9 volts to 20·5 volts, the pressures ranging from 1·26 mm. to 0·14 mm. The method adopted was to measure the maintenance potentials when a given number of striations was included between the electrodes. The distance between the electrodes was then increased so as to include one, two, or three more striations, and the maintenance potential again measured.

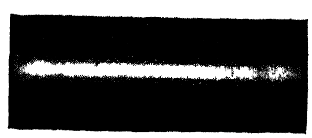

FIG. 5.—Pressure, 0·1 mm; diameter of tube, 1 6 cm; distance between electrodes, 17·5 cm.; λ=80 metres.

The following table gives the results for a wave-length of 80 metres and a tube 2·9 cm. in diameter, where V is the potential required to maintain four

striations, and V_s the additional potential for each additional striation.

Pressure.	V_m.	V_s.
1·26	66·3	9
0·31	90·1	14·8
0·14	120	16·2

S. P. MCCALLUM.
W. T. PERRY.

Electrical Laboratory,
Oxford.

Critical Potentials of Light Elements for Simultaneous Transitions.

INVESTIGATIONS have been made by various workers to determine the energy levels of the outer shells of the atom by bombarding it with cathode particles of definite velocity and measuring the photoelectric current due to the radiation impinging on a metallic plate. Keeping the cathode current constant through the tube, the voltage is gradually increased, and it is found that at certain voltages kinks appear in the voltage-photoelectric curve. These kinks are attributed to the sudden appearance of 'new types of radiation' and the corresponding voltages are called 'critical potentials.'

Numerous observers (Richardson and Chahklin, Rollefson, Horton, Thomas, Compton, and others) have measured the critical potentials for the elements chromium to copper in the region from 40 to 200 volts, and in spite of certain disagreements between some of these values, due chiefly to the different values taken for W (the work necessary to remove the electron out of the metal) by different observers, it is found that there is a good agreement between them for about ten of these critical potentials, though these numbers are very much more than what is to be expected from the Bohr atomic model. For example, Andrews, Davies, and Horton (*Proc. Roy. Soc.*, vol. 117) have obtained critical voltages for copper in this region corresponding to 56, 67, 75, 85, 116, 131, 153, 196, 212 volts, whereas from the Bohr model one would expect critical voltages at 76·9 (M_2, $M_{\text{II}}-M_{\text{III}}$) and 119·7 ($M_1$, M_{I}) only.

Attempts have been made to explain the origin of the critical potentials by different observers, but none of them has been able to get the right result even qualitatively, though Richardson and Thomas have suggested the possibility of double ionisation in the atom.

In a previous communication to NATURE (Nov. 17, p. 771) one of us (B. B. R.) tried to account for the existence of secondary absorption edges by supposing that the same quantum of radiation can successively knock out two electrons occupying the same or different energy levels in an atom. In a similar way we can explain the appearance of these critical potentials by assuming that in certain circumstances the same cathode particle can simultaneously eject two electrons either from the same or from different energy levels of the atom, and radiation is emitted due to simultaneous jumps of two electrons to fill up these two vacancies. The frequency of the radiation then emitted is equal to the sum of the frequencies due to the individual jumps. The idea of the emission of single quanta, as the result of the simultaneous transitions of more than one electron, has been already established in the field of optics (see Andrade, "The Structure of the Atom," pp. 563-564).

With this idea we have plotted Moseley curves with $\sqrt{\nu/R}$ as ordinate against Z in the region from iron to copper for such transitions as $2M_1$, $2M_2$, M_1+M_3, M_2+M_3, $M_1+(M_1-M_3)$, $M_2+(M_2-M_3)$, and so on. The values for M_1 and M_2 in this region are taken from X-ray, and N_1 from the optical data, whereas M_3 is obtained by extrapolation. On comparing the common values of different observers with those from the curve in these regions, we find that out of ten critical voltages, eight can be explained in this way; the error in any case is not more than 5 per cent. The values for chromium and manganese can also be deduced with success from these curves by interpolation. As for the other values, we are not sure if these are due to tungsten or to other impurities present in the metal. We also wish to point out that a large number of lines would accompany each of the transitions considered here in accordance with the Pauli-Hund rule as applied in the optical spectra.

This hypothesis of simultaneous transitions thus appears able to explain satisfactorily a large mass of hitherto unexplained experimental determinations of critical voltages.

B. B. RAY.
R. C. MAJUMDER.

University College of Science,
Calcutta.

The Electromotive Behaviour of Single Metal Crystals.

ALTHOUGH the results of crystal analysis indicate that the electromotive characteristics of a metal, in common with other properties conditioned by interparticle electrostatic forces, presumably vary with the orientation of the surface measured, no attempt seems to have been made to relate electrode potential measurements to a structure definitely describable in the crystallographic sense. The study of this structure-potential relation seems particularly desirable if electromotive data are to be correlated with photoelectric and electron condensation measurements. The measurement of a definite cleavage plane of a typical single metal crystal suggests itself as a suitable starting-point for such a study.

Measurements in oxygen-free solutions carried out at Yenching University, Peking, between June 1927 and June 1928 on three single zinc crystals, one of which was furnished by Prof. Bridgman, indicate that the primary cleavage face (basal pinacoid) of a zinc crystal is capable of yielding potentials constant to within 0·0001 volt and reproducible to well within one millivolt. The potential, further, was identical to that of the electrolytically deposited crystal conglomerate within the range of variation of duplicate conglomerate electrodes, a result which would be predicted if, as Bozorth (*Phys. Rev.*, **26**, 390; 1925) has shown, the electrolytic crystals are deposited with a random orientation and if the potential of the primary cleavage is a unique maximum. This second condition is rendered probable by the fact that the interplanar lattice distance is a maximum at the basal cleavage, but would depend upon any variation of the photoelectric work function with orientation. Attempts to prepare zinc crystals with naturally developed secondary faces sufficiently large for measurement have so far failed. Measurements on artificially prepared surfaces annealed and lightly etched have seemed to indicate a qualitatively regular decrease of potential with increase of inclination to the primary cleavage plane. This result is being checked by further work.

It may be pointed out that the use of the single crystal electrode offers a possible solution of the problem of obtaining satisfactorily reproducible electrodes of the high melting-point, rigid lattice metals.

PAUL A. ANDERSON.

Yenching University,
Peking, China.

Investigations of the Scattering of Light.

PROF. C. G. DARWIN, in his interesting account in NATURE of Oct. 20, 1928 (p. 630), makes a reference to recent work on the scattering of light. It appears desirable in this connexion to point out that the existence in the light scattered by liquids and solids of radiations of modified wave-length was established so early as 1923 by investigations made at Calcutta. Dr. K. R. Ramanathan showed (*Proc. Ind. Assn. Sc.*, vol. 8, p. 190; 1923) that when violet rays pass through carefully purified water or alcohol there is an appreciable quantity of radiations in the green region of the spectrum present in the scattered light. Further studies of the effect in other substances are described by Mr. K. S. Krishnan in the *Phil. Mag.* for October 1925 and by me in *Jour. Opt. Soc. Am.* for October 1927. These investigations were of course well known to workers in this field.

In a lecture delivered at Bangalore on Mar. 16, 1928, and published and distributed on Mar. 31, investigations were described showing *first*, the universality of the effect, namely, that it is observed in the widest variety of physical conditions (gas, vapour, liquid, crystal, or amorphous solid) and in the largest possible variety of chemical individuals (more than eighty different substances); *secondly*, that the modified radiation is strongly polarised and is thus a true scattering effect; *thirdly*, that each incident radiation produces a different set of modified scattered radiations; *fourthly*, that the scattered radiations consist in many cases of fairly sharp lines in displaced positions; and *fifthly*, that the frequency differences between the incident and scattered radiations represent the absorption frequencies of the medium. These observations established and emphasised the fundamental character of the phenomenon in a manner which any isolated observation with a single substance would have quite failed to achieve.

The Russian physicists, to whose observation on the effect in quartz Prof. Darwin refers, made their first communication on the subject after the publication of the notes in NATURE of Mar. 31 and April 21. Their paper appeared in print after *sixteen* other printed papers on the effect, by various authors, had appeared in recognised scientific periodicals.

C. V. RAMAN.

210 Bowbazar Street,
Calcutta, Nov. 13.

A Fresh-water Medusa in England.

THE first record of a fresh-water jelly-fish in England was made by Sir Ray Lankester in a letter to NATURE, June 17, 1880. This little jelly-fish was found in the *Victoria regia* tank of the Botanical Society in Regent's Park, and is most widely known as *Limnocodium Sowerbyi*. By a deplorable decision of the Commission on Zoological Nomenclature, however, some modern writers have changed the generic name to *Craspedacusta*.

I have now to record the occurrence of another fresh-water medusa in a private aquarium in England. The discovery was made by Mr. Vernon Poulton, of Boscombe. With great skill and patience he succeeded in finding not only the free-swimming medusæ but also the very minute fixed hydrosome stage, and he has allowed me to see his preparations of both.

The medusæ undoubtedly belong to the genus *Microhydra*, which has hitherto been recorded only from North American waters, and I see no reason for suggesting that they differ from the type species *M. Ryderi*.

Among the water-weeds in the aquarium in which the medusæ were found were some plants of the American genus *Salvinia*, and it is possible that the *Microhydra* was imported into England attached to this weed; but according to Mr. Poulton's observations, the hydrosome stage was always attached to grains of sand and not to the *Salvinia*.

I wish to appeal to persons who cultivate *Salvinia* or other American water weeds in England to examine the water in their aquaria from time to time to see if these medusæ make an appearance. They are colourless and almost transparent, and the diameter of the bell is about 1 mm., or $\frac{1}{25}$ inch. The number of tentacles varies according to the age of the specimen, but there may be as many as twelve.

The medusæ of *Microhydra* may appear in large numbers and then disappear for a long period, just like the medusæ of *Limnocodium*, so that several observations should be made at different times of the year before abandoning the search.

In conclusion, I may say that, notwithstanding the opinion expressed by Mr. F. Payne in a recent paper, I am convinced that *Microhydra* is generically quite distinct from *Limnocodium*.

SYDNEY J. HICKSON.

Cambridge,
Dec. 10.

The Instability of a Single Vortex-Row.

SIR CHARLES SHERRINGTON, in NATURE of Sept. 1 last, directs attention to the eddy effect which in a heart valve "prevents extreme eversion of the valve, and facilitates closure of the valve without delay or hindrance so soon as the diastolic check of the stream current ensues."

It may interest readers of NATURE to know that this effect was described very clearly by Prof. George Britton Halford, the founder of the Medical School in Melbourne, the first in Australia. His views were published in the *Lancet* and in a local medical journal, but perhaps most fully in a book, "The Action and Sounds of the Heart" (Churchill, 1860), from which I quote the following: "A bullock's heart was obtained, and the auricles cut away nearly as low down as the auriculo-ventricular openings; the cavities of the ventricles were well washed out, and the coagula carefully removed. A vulcanised india-rubber tube of like diameter with the pulmonary artery was then attached by one extremity to the vessel, and by the other to a common forcing pump; water was then thrown into the pulmonary artery, and the semilunar valves tightly shut down, gentle pressure being maintained, in imitation of what takes place in life. The right ventricle, being empty, was in the same state as when the auricle is about to inject it. On pouring water into the ventricle the flaps of the auriculo-ventricular valve rose upon the surface of the fluid, until (the ventricle becoming fully distended) the valve formed a perfect septum between it and the auricle. The left side of the heart was tested in the same manner, and with results perfectly the same, notwithstanding the greater thickness of the valve, the larger size of the musculi papillares, and the stronger chordæ tendineæ."

I find that it is not absolutely necessary to have the emergent artery closed under pressure. The experiment in this simple form is made by my students individually—we call it Halford's Experiment—and always excites interest.

W. A. OSBORNE.

The University of Melbourne.

Nitrogen Fixation: the Growth of a New British Industry.[1]

HAVING now in general terms surveyed the *raison d'être* and the state of development of this modern industry, we will consider the circumstances of its establishment in Great Britain, and the remarkable vigour of its growth under the direction of the Imperial Chemical Industries, Ltd.

The War had been in progress for some time before the importance of the catalytic process for the production of ammonia, as a preliminary to its catalytic oxidation to nitric acid, was sufficiently realised outside scientific circles. In due course, however, the Nitrogen Products Committee was established and, whilst recommending the cyanamide process as being the only possible process concerning which sufficient information was then available, organised research in other appropriate directions. Much careful investigation was carried out and valuable results were accumulated, although at that time naturally not published. As a result of the work of Greenwood, Rideal, Partington, and others at University College, London, the Department of Explosives Supply decided in 1917 to erect a plant at Billingham, near Stockton-on-Tees, for the purpose of producing ammonium nitrate by Haber's process, a grant of five million pounds being made to finance the project. However, when about a quarter of this sum had been spent, it was found that the dimensions of the task were so great as to prevent its completion in time to be of military value. The whole scheme was re-examined in 1919, and considered to bear promise of fruition as a peace-time industry. Negotiations led finally to Messrs. Brunner, Mond, and Co., Ltd., agreeing to take over the assets and liabilities of the concern early in 1920, the technical staff, which had meanwhile been kept actively in being, moving to Billingham in June of that year; at the same time the subsidiary company, Synthetic Ammonia and Nitrates, Ltd., commenced its official existence. Now, of course, both of these companies form part of Imperial Chemical Industries, Ltd.

The whole problem had to be studied afresh from the beginning, and the first move was the establishment of a research laboratory, which, incidentally, cost some £80,000 (see Fig. 1). Simultaneously, a small plant was erected at the works of the Castner Kellner Co., Ltd., at Runcorn, where pure ammonia has been made continuously since June 1921 in increasing quantities. The hydrogen employed was a waste product in the electrolysis of brine for the manufacture of caustic soda and chlorine. The experience so gained was found to justify the erection of a complete plant at Billingham, using as much as possible of the old material, and designed for the production of 30 tons of ammonia per day; so rapidly and enormously has the factory grown (see Figs. 2 and 3) that the present capacity of 70,000 tons of fixed nitrogen per annum will, in 1929 or 1930, have been increased to 170,000 tons annually of fixed nitrogen, all of which, except for a comparatively small quantity employed in refrigeration, is used for the production of compounds of importance in agriculture, the dye industry, artificial silk industry, etc. In the meantime the village has become a small town, where 6000 employees will, in a couple of years, have been joined by a further 9000; where plans for 500

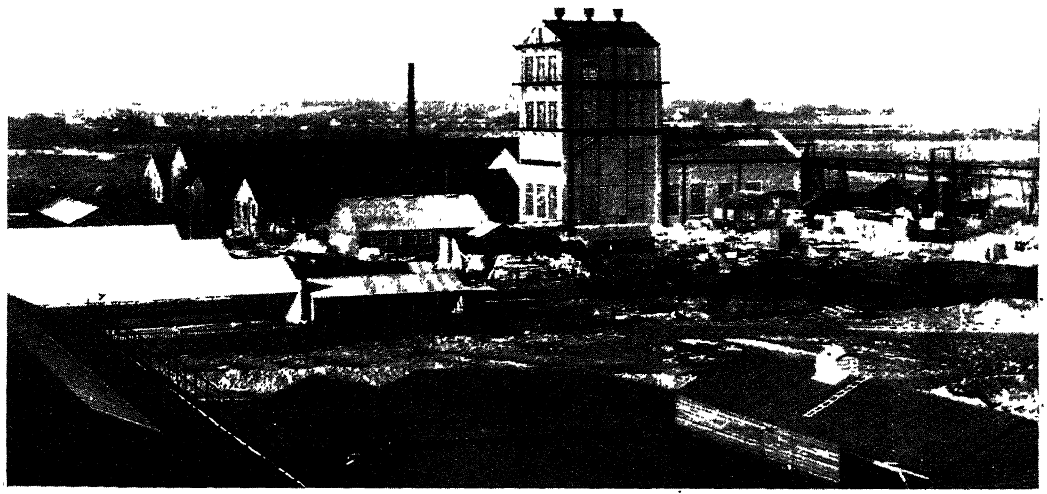

FIG. 1.—The laboratories of Synthetic Ammonia and Nitrates, Ltd., Billingham.

[1] Continued from p 20.

houses, an entertainment hall, and a pavilion have been approved, and 500 more houses are in contemplation; where new playing fields and tennis courts are being provided; where, in short, a new industrial community is being established.

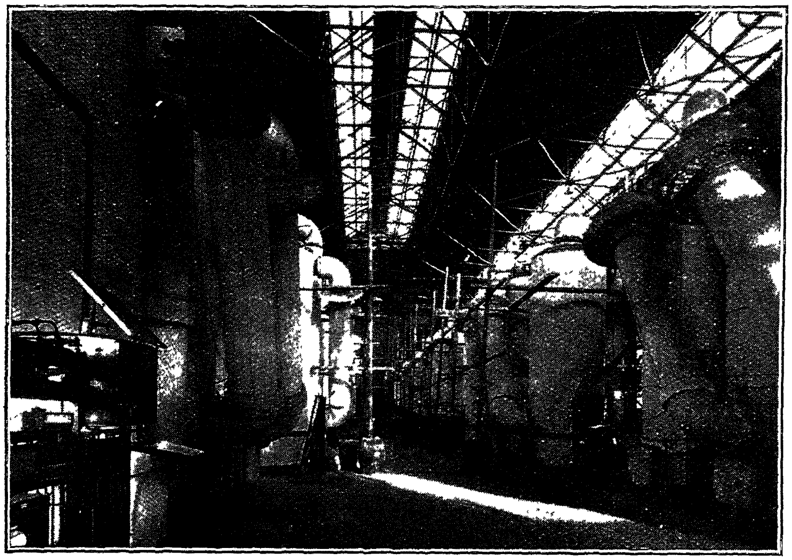

FIG. 2.—New hydrogen plant.

The technique of the production of ammonia by the Haber-Bosch process is essentially the technique of high-pressure reactions. It was immediately found that the ordinary types of plant, such as were then obtainable, were entirely inadequate for the needs of the new processes, so that the company was compelled to pioneer in this direction also, carving out its own path and learning during its progress. That the task of design and manufacture of such high-pressure apparatus is being satisfactorily accomplished is evident from Lieut.-Col. Pollitt's statement that the plant is in many respects simpler to operate and easier to maintain than low-pressure plant (see Fig. 4). The process, in outline, is as follows. Air and steam are together passed through incandescent coke in gas generators which provide for the efficient conservation of heat and full automatic control. From the product, which consists of hydrogen, nitrogen, carbon monoxide, and carbon dioxide, the carbon monoxide is removed by catalytic interaction with steam, and the carbon dioxide by treatment with water under pressure; the hydrogen and nitrogen in the proportion by volume of 3 : 1 are then highly compressed and subjected to the action of the catalyst in converters the working temperature of which is 500° C. The ammonia is dissolved in water and combined with some of the carbon dioxide previously removed. In order to avoid the use of sulphuric acid in converting this ammonia into sulphate, the more economical process of causing the ammonium carbonate to react, in aqueous solution, with anhydrite (calcium sulphate) is employed. Not only is the material ready at hand—there is a large deposit of anhydrite some 700 ft. below the site of the works—but also the calcium carbonate which is precipitated in the reaction is of industrial value, being produced in a form suitable for the manufacture of Portland cement, or for combination with ammonium nitrate to produce a new fertiliser known as 'nitro-chalk,' or for direct application to the land. Other products are ammonium bicarbonate, anhydrous ammonia, and nitric acid (see Fig. 5), the last-named substance being, of course, produced by catalytic oxidation of the ammonia.

Naturally, the experience gained in high-pressure technique is being simultaneously applied to reactions other than that from which it originated, such, for example, as the production of methyl alcohol from water gas by a catalytic process. It may eventually be possible to manufacture higher

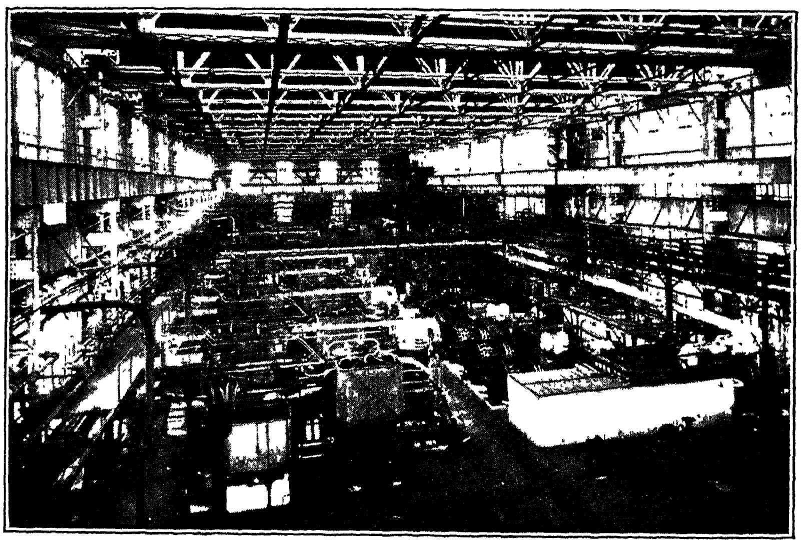

FIG. 3.—Ammonia plant.

alcohols by means of this type of procedure, and the possibility of the conversion of methane, obtained by the distillation of coal, into acetylene and hence into numerous organic substances, is not to be ignored. These developments have necessitated laboratory and research staff extensions in

rapid succession, for although the routine work has naturally increased, it remains a comparatively small fraction of the whole. The growth of an efficient instrument service, whereby so many different kinds of operation can be recorded and often controlled, whilst bringing in its train an important group of physical problems, simplifies in no small measure the task of accurate and knowledgeable control, and frequently indicates directions in which improvements are desirable.

It will be seen that the trend of industrial chemistry evidenced by the work at Billingham under the direction of Imperial Chemical Industries, Ltd., is no less than the replacement of products obtained from agricultural operations by products obtained from coal. Such a policy is in consonance with an era of mechanical transport, and it is peculiarly applicable to the British Empire. Although, as has been indicated, in any future war the fixed nitrogen industry might well find itself the base on which successful military action rested, and Billingham, Newcastle, and Birmingham might typify the pivot around which policy might revolve, it must emphatically be realised that the existence and development of this industry is a requirement, and an urgent one, of times of peace. It tends to bring comforts of modern civilisation within the reach of greater numbers, and its aim is to make two blades of grass grow where one grew before.

How far it succeeds in this latter aim can be judged, for example, from statistics supplied by Dr. H. J. Page, head of the Nitram Experiment Station, which is operated by Nitram, Ltd., an associated company dealing with the application of the products manufactured by Synthetic Ammonia and Nitrates, Ltd. Dr. Page shows that by giving grassland at eighty centres in the British Isles a basal dressing of phosphate and potash, and then successive dressings of ammonium sulphate at short intervals, the productivity is so increased that instead of two acres, only 0·72 of an acre is necessary to feed one cow. As Sir Daniel Hall has pointed out, British farmers can now modify the traditional practice of understocking. The British farmer, however, being somewhat conservative, and preferring usually to see before he believes, a 'Nitram' demonstration van tours the country in order to explain the new uses of sulphate of ammonia and nitro-chalk; the van carries instructional leaflets, specimens of the products of Synthetic Ammonia and Nitrates, Ltd., specimen turves, etc. A statement made at the second International Nitrogen Conference in the spring of last year by Sir Frederick Keeble is also worth recording, indicating as it does the margin between practice and possibility which is available for exploration and exploitation. He remarked that at a recent potato-growing competition organised by Nitram, Ltd., in Northern Ireland, the winner raised a crop of 28 tons to the acre, and no competitor raised less than 15 tons to the acre, whilst the average in England is less than seven tons per

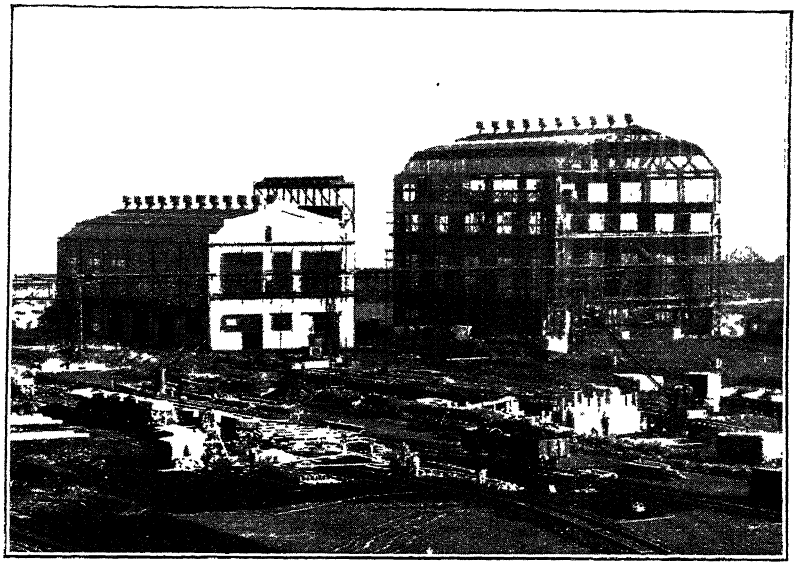

FIG. 4.—Buildings for new high pressure plant

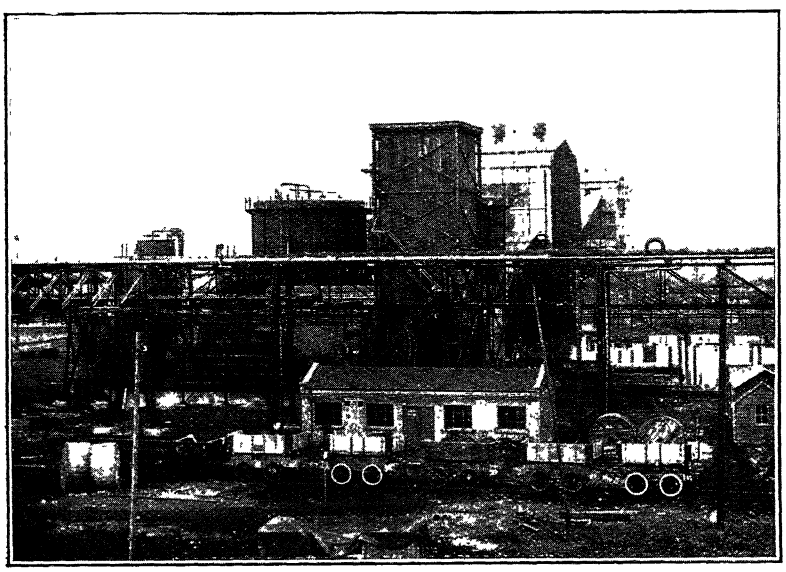

FIG. 5.—Nitric acid plant.

acre. Parenthetically, it must be noted that although fixed nitrogen is of such great importance in fertiliser practice, soil requirements of other elements have also to be provided. Examples of the influence on crop yield of systematic fertilisation might be multiplied. So also might examples of neglect to profit thereby. For example, a correspondent to the *Times* (British West Africa Supplement, October 1928), describing farming conditions in Sierra Leone, writes: "... The second problem is that of maintaining the fertility of permanently cleared land by suitable manuring. There are practically no horses and very few cattle.... In consequence there is no form of farmyard manure available, and the average native farmer sets more store on putting up some sort of 'ju-ju' to protect and encourage his crops than on considering the purchase of artificial manures." Ju-jus, let it be observed, are of divers kinds.

The growth of the fixed nitrogen industry has lowered the prices, in terms of goods, of all nitrogenous fertilisers, and of phosphates and potash also, but we still lack sufficient accurate and co-ordinated scientific knowledge of the extent of the benefits which may be ours; of the factors determining soil fertility and climate; of the state of combination, interactions, proportions, and variations in the elements concerned. At Rothamsted it has been realised that although an enormous mass of data was being accumulated, it was not being employed to the best advantage by older methods of examination, and in consequence modern statistical methods have been applied. These methods have opened up a new line of study —the study of the influence of nutrients on the reaction of the plant to environmental conditions, that is, the influence of soil and climatic conditions on the effectiveness of fertilisers. Those in the best position to judge have declared that, if the general character of a season could be predicted, appropriate manurial schemes could be recommended, or tables of expectancy of crop yield could be constructed for the guidance of insurance companies willing to insure farmers using recognised fertiliser mixtures against getting less than an agreed yield per acre.

Finally, we must not, in contemplation of a rosy future, lose sight of the realities of the present. Unless new knowledge is acquired, unless education in the modern use of nitrogenous fertilisers is advanced, the danger of overproduction may be great. Mr. F. C. O. Speyer, the general manager and a director of Nitram, Ltd., estimated that if announced programmes in various countries are carried out, there should be an extra production of about $2\frac{1}{4}$ million tons of nitrogen between June 1928 and June 1931. He calculates that, although 92 per cent of this could be absorbed by Europe alone if applied to main crops at the rate of 0·8 cwt. per acre, the additional world population in this period would not consume more than half of the extra food which would thus be available. On the other hand, Dr. Bueb, managing director of the Stickstoff Syndikat, has pointed out that the monetary return on the use of nitrogen has steadily risen, and the prices of foodstuffs have been kept down. The problem of production is subject to the economic laws, but co-operation between the forces concerned—those directed by the chemist, the engineer, the agriculturalist, and the plant breeder, is so full of economic possibilities that it would indeed be unwise to base our estimate of to-morrow's need solely on to-day's demand.

A. A. E.

Biology and Education.[1]

By Prof. F. A. E. CREW.

THE method of education is the stimulation of the cells of the brain by impressions from without: impressions provided by the casual and haphazard incidents of experience and by the deliberate and systematic agencies concerned with the imparting of facts and opinions. The aim of education is so to guide the development of the individual that he can hope to discover his powers, to recognise his limitations, and to determine the ways in which he may achieve the fullest degree of expression of his inherited mental and physical endowment in the circumstances, physical and social, in which he will find himself. Education, therefore, is concerned with the living individual and with the habitat in which this individual is to live and, living, achieve his destiny. So also is biology, the science which deals with the nature of living things and with the relation of these to their environment. It seeks to find answers to the questions as to whence came man, what is man, and whither goeth he. These are the very questions that occupy the popular mind to-day. Surely the tasks of the educationist must be those of equipping his experimental material with the ability to formulate these questions properly and of showing how and where their answers may be found.

The most conspicuous factor in the history of civilisation during the last two hundred years has been the exploitation of physical Nature by means of scientific knowledge. Science has provoked and made possible a complete metamorphosis of the western world since the middle of the eighteenth century, and during this time science has been nurtured by industry. The Europeanisation of the world had its origins in the developments of commerce, and the broadening of the mental outlook which distinguished the Renaissance was made possible by the increased wealth and the increased leisure this commercial prosperity gave to western peoples. The industrial revolution in England was but the inevitable sequel of the developments of trade during the period 1600–1750, and the present-

[1] From an address delivered before the Incorporated Association of Assistant Masters in Secondary Schools at Brighton on Jan. 1.

day appreciation of scientific knowledge in relation to the practical affairs of life is again the inevitable outcome of this industrial revolution.

It is because man has gained so spectacular a control over his physical environment that science exercises such a dominant influence in Western culture to-day; and it is because commerce has encouraged the development of the physical sciences for its own ends that physics and chemistry and allied sciences have grown so amazingly. But it is not because these sciences are so much more complete than are the biological that they find a place in the school curriculum. It has yet to be shown that physics and chemistry are keener tools wherewith to fashion mind than is biology. I submit that they are now taught simply because they have been taught, and because they are not only useful educational instruments but also profitable when the pupil is translated to secondary school, technical college, and university. Industry is demanding men trained in the physical sciences, and a knowledge of these subjects, while it may be helpful in a cultivation of the art of living, is most certainly useful in the business of earning a living. If men were bought and sold to-day, as they used to be, doubtless human biology would possess an equal importance.

No part of one's general education should be coloured, however, by any consideration of what one will do in order to live: general education is concerned solely with the development of an art of living, of teaching the developing individual how to think and how to feel and how to seek and gain opportunities for exercising these faculties. Manifestly, during this period the individual must receive an introduction to science, since it is of the utmost importance that youth should acquire the scientific point of view. Science has done more than merely give to man a marvellous power over material things: it has revolutionised human thought. It is this spiritual aspect of modern science that is its most significant virtue. The revolution is still spreading, and it is in a world dominated more and more by this scientific habit of mind that our pupils are to live.

Science has completely changed the concept of authority. Credulity is no longer accepted as a virtue and doubt as a sin. The final authority in spiritual as well as in temporal matters is no longer Scriptural phraseology and the traditional teachings of the sages of antiquity. The Old Testament is no longer accepted as a trustworthy text-book of human biology. Belief must now rest upon evidence that is open to examination, and critical judgment has usurped the place of authoritative statement. To-day, mankind demands the right to seek the truth and to extend it without restriction: facts, verifiable facts, are the only justification for authoritative statement. This concept has to be presented to and accepted by the youth of to-day.

It was this revolution in human thought that led to the replacement in education of the asceticism and scholasticism of the Middle Ages by the humanism of the Renaissance and later to the replacement of this in turn by science. To escape from the scholasticism that was becoming obnoxious it was necessary to turn to the literature of Rome and Greece. Latin, the language of the learned, became the vehicle of the new humanistic philosophy, and, because the new ideal found its counterpart in the thought of ancient Greece, Greek became the pathway to this older source of European culture. For these reasons, Latin and Greek assumed positions of great importance in education. Times have changed, yet even now the position of these classical languages in educational schemes is robustly defended, though the original need for their teaching has disappeared. The authority of tradition, enunciated in the pronouncements of classical scholars, no longer convinces. The average man can, and should be encouraged to, capture the spirit of this humanism in adequate translations and interpretations; if these do not exist, then the classical scholar is blameworthy: no one can afford to disregard the attitude of mind which requires that there shall be a spiritual joy in living and a confidence in the future, but the languages themselves are now the delicate hobbies of such as find more joy in the contemplation of the affairs of yesterday than in the adventures of living to-morrow. Every man does not require a knowledge of Greek, but he will require each day and every day a knowledge of the physico-chemical mechanism that is himself.

The acid test of scientific method is now applied in education, and the classics have been eroded. The day of passive acceptance of that which is, because it has been, is passed. It will be agreed that we are incredibly ignorant of what constitutes scientific procedure in education. It will be agreed, further, that because certain time-honoured standards have been overthrown the new ones are not necessarily final. The value of science in the school curriculum is that it can replace adequately the humanistic philosophy of life in combating and vanquishing fear of the unknown. This it is that physics and chemistry do, and that biology could do even better. The time has already arrived when physics and chemistry, sciences that deal with the phenomena of man's environment, should make room for biology, for it is biology more than anything else that is modifying human thought. To-day, the philosopher recognises the biological foundations of philosophy, the theologian the biological development of theology, the historian the biological framework of historical events. But more important than all this is the fact that the average citizen is intensely interested in the biological nature of his own existence. Biology occupies a pivotal position in human understanding, for mankind, having conquered its environment, is now seeking the control of itself and its destiny. The life of every man is affected in all its aspects by the two great generalisations of biological science—the theory of the cell and the theory of organic evolution. An introduction to these theories should therefore be given to all as part of their general education.

In the specialised scientific education that follows

upon the general, biology is a necessity; it is as indispensable for the embryonic chemist and physicist as are physics and chemistry for the biologist. Biology is no longer fragmented into the watertight compartments of zoology, botany, and physiology. Comparative morphology is no longer over-emphasised, and through the developments in genetics, ecology, and experimental morphology the barriers between zoologist, botanist, and physiologist have been broken down. The necessity for studying the physico-chemical processes of living organisms requires that the biologist shall be physicist and chemist as well, and the physicist and chemist with a knowledge of biology can find ideal material for the exercise of their techniques—the day of the biochemist and biophysicist has already dawned.

Biology in its origin was closely associated with medicine and with agriculture. The more scientific medicine and agriculture become the greater will be their demands upon biological science. As biology becomes more exact in its conclusions it will claim an even greater value in the social sciences, in which fields its main contribution as yet is the point of view which it imparts. But the significance of zoological and particularly of medical knowledge is becoming evident to the social worker, whose eagerness for the facts of heredity and hygiene is remarkable and will persist. When once there has developed a biology of the group, a scientific interpretation of human behaviour, then biology will indeed exert a most profound effect upon the social activities of humanity. The problems of evolution are no longer solved through the exercise of pure dialectic; biology has progressed towards the method of experimental analysis, and because its conclusions rest increasingly upon experimentation they are held in higher esteem. The voice of the biologist is now eagerly heard, because he speaks of facts that cannot be denied, of facts that concern the welfare of mankind.

Biology is not commonly included in a school curriculum, for the reason that the headmasters of yesterday had no knowledge of the biology of to-day. It cannot be expected that most teachers of physics and chemistry should themselves agitate for the appointment of a biological colleague, for the reason that it is quite obvious that the total amount of time allotted to science in the school curriculum cannot be advantageously increased, so that if biology enters the school it must necessarily reduce the time now given to physics and to chemistry. It is but to be expected, however, that I, a professional biologist in spite of my school education, should seek to advance the interests of my own subject. Science advances through the general acceptance of its teachings as much as by additions to knowledge. The teacher who pursues the implications of science and induces others to follow his example is no less important to scientific progress than he who contributes to the establishment of some technical generalisation.

In a university curriculum there is no time to present biological facts in a romantic fashion, and in any case the student's capacity for recognising the wonders of the living organism that is himself is spoiled somewhat by the economic necessity of equipping himself vocationally in the shortest possible time. He may become a biologist in later years, but at the university he is far too much occupied in his painful metamorphosis into a doctor, an agriculturalist, a veterinarian, an entomologist, or what not. Only those matters that seem to possess an importance to him in his professional capacity are of any real interest to him during this phase. Seldom does he capture the spirit of science; scarcely ever does he exhibit the scientific attitude of mind. Soon we shall see biology alongside chemistry and physics as a pre-registration subject: it would be that even now if the mechanism for teaching it existed in the schools. I, for one, look forward to the time when biology will be taught in the schools by carefully trained men, for school is the place where one should receive one's introduction to biology. That is the time and the place to give to the temperamentally suitable the spirit of the naturalist. This should be the endowment the school should give to youth.

At the present time the schools are providing the universities with a more than adequate supply of botanically attracted maidens, whereas what we need is an increased supply of young men who know that they are destined to be biologists. It is not because chemistry and physics are ultimately more profitable than biology that so many university students attend these courses; it is because so few have had biology at school, and because the majority of youths are urban-bred. At the present time there is a demand for men with a biological equipment that cannot be supplied. Imperial schemes for the advancement of agriculture are even now being embarrassed in their development because there are no young biologists to accept the posts that have been created. In the Dominions and Colonies, agriculture is the all-important industry, and in agriculture a knowledge of biology is of greater usefulness than is a knowledge of physics. Commonly, I am asked for advice concerning the prospects for a trained biologist. I answer that a well-trained man of suitable personality can readily start on a career which offers him a salary advancing from about £300 to £1000. To those who argue that this is not so good as a career in medicine, law, or commerce, I reply that I, for one, get from life rewards that cannot be found outside biology.

What is more important to humanity than the manufacture of helminthologists, entomologists, and the like is, however, the further extension and democratisation of the evolutionary concept. It was this that overthrew the medieval theology and completed the enlarging of the mental horizon of humanity. Man's notion of himself has changed from that of a being recently created and awaiting a day of reckoning in a not too distant future to that of a being originating as part of organic Nature and set in a universe without beginning and without end. This intellectual revolution has emancipated countless men from the bondage of authority. It

must free all. The evolutionary concept has been applied to religion and to philosophy. Its influence is seen in sociology in the incessant questioning of the necessity for existing conditions—it has shaken the whole edifice of social tradition. Disease and crime are no longer regarded as inevitable consequences of the organisation of society to be treated by curative measures. They are being attacked with all the scientific knowledge that we now have, and it is intended that they shall be eliminated by the evolution of a type of man and a form of society in which they will not exist. Man is no longer content to allow natural forces to work their will upon him; he has challenged Nature, bending it to his will, and hereafter will direct his own evolution.

The biological discovery of man's place in Nature has created the need for a biological training for priests and law-makers, for further developments of civilisation will be made possible only through the growth of biological knowledge. The nineteenth century saw revolutionary advance in the physico-chemical field; the twentieth will see equal advance in the domain of biology. In the past, man's control has been over inanimate things: now the conquest of living Nature has begun.

Antarctic Discoveries.

IN his nine hours' flight of 1200 miles over Graham Land on Dec. 19, Sir Hubert Wilkins made discoveries of great value. This was the first flight ever made in Antarctic regions and shows the value of air transport for the explorer in a part of the world where pioneer work has yet to be done. In a few hours, travelling at a speed of 120 miles an hour, Sir Hubert reached farther south than any ship has ever been able to penetrate on the eastern side of Graham Land, where Captain Larsen in 1893 had managed to reach lat. 68° S. Previous knowledge of the coasts of Graham Land ended, with any detail, on the eastern side in about lat. 66° S., and on the western side in about lat. 69° S. Beyond these latitudes, and even to the north of them in many places, knowledge was very sketchy.

The main features of Sir Hubert Wilkins' discoveries can be gathered from his dispatches to the *Times*. From Deception Island he and Lieut. Eielson flew south over the high peaks of Trinity Peninsula and the King Oscar coast, and almost exactly on the Antarctic Circle found an ice-filled twisting channel joining the Weddell and Bellingshausen Seas. The eastern end seems to open between the Weather (Wetter) Island of Larsen and another large island lying about 50 miles farther south. From the description, this island would appear to belong to the zone of basaltic rocks that lies to the east of the folded zone of Graham Land.

The eastern end of this strait was missed by Larsen and Nordenskjöld. Larsen was too far east owing to the wide ice-shelf on that coast preventing his ship approaching, and Nordenskjöld's farthest south on his sledge journey in 1902 was about lat. 66° S. Yet at that point he had a vague suspicion of the existence of a very long inlet if not a strait. At its western end the strait discovered by Sir Hubert Wilkins no doubt opens into the great Auvert Bay which Dr. Charcot placed north of his Loubet Land. Auvert Bay has not been explored and its eastern end is left blank on the charts. The *Times* reports that this new strait has been named Crane Channel.

Farther south Sir Hubert Wilkins reports that the rugged ranges of South Graham Land decrease in height but rise again towards lat. 70° S. In that latitude there exists a second strait, named Stefansson Strait, forty to fifty miles wide joining the Weddell and Bellingshausen Seas. Beyond this the ice cliff which borders the Weddell Sea from Coats Land westward seems to continue. Very possibly it continues through the strait, borders the Pacific Ocean, and reaches King Edward Land. About here Sir Hubert was forced by lack of fuel to turn, but he writes of the ice-covered surface sloping upwards to the south, which suggests the high plateau of Antarctica. This part of Antarctica receives the name of Hearst Land. The mainland of the southern continent is probably entirely of the same plateau structure with conspicuous fault ranges in the Ross Sea area. The theory that any part of the mainland is a region of Andean folding must now apparently be abandoned.

These details will of course be amplified in the course of time and the photographic record of the flight will help to make the picture complete. At present the news suggests that the folded ranges of Graham Land are lost by depression in about lat. 70° S. They probably skirt the ice-covered plateau of Antarctica, appearing as emerged land in such areas as Alexander Island, Charcot Land, the volcanic Peter Island, and perhaps King Edward Land. So little, however, is known of King Edward Land that its participation in the Andean folds cannot be stated with certainty. The existence of many large tabular bergs off Alexander Island, which appears to lie near the western end of the large strait, suggested to Dr. Charcot many years ago that shelf or barrier ice could not be far distant from that coast.

Sir Hubert Wilkins' discoveries thus throw light on one of the chief problems of Antarctica, namely, the relation of the folded Andean structure of Graham Land and the plateau structure of Victoria and adjacent lands and probably of Coats Land. The more striking discovery of the straits across Graham Land is actually of less importance. It has been known since the days of the *Belgica* expedition towards the end of last century that Graham Land was a heavily submerged area. Its continuity with the folds of South America has been lost by submergence. Belgian and French expeditions on the west, and Swedish and other expeditions on the east, have shown the extent of submergence in outlying archipelagoes and deep inlets. Channels crossing from coast to coast are not surprising in such a land. In South America such channels occur in the far south. These newly

discovered straits are probably seldom if ever clear of ice: in fact, they are probably filled with shelf or barrier ice rather than sea-ice.

Unfortunately, Sir Hubert Wilkins could not land, as his machine had wheels and he saw only snow surfaces fit for ski. But the discoveries show the way for future work, which it is to be hoped may be done at least in part by Sir Hubert himself during the present season. A flight from Deception Island to Com. Byrd's base at the Bay of Whales in the Ross Sea could not fail to have interesting results, but it would be a long flight and a far more hazardous than the one already accomplished. R. N. R. B.

Obituary.

DR. C. R. YOUNG, O.B.E.

CHARLES ROBERT YOUNG was born at Nottingham on Mar. 4, 1880, and was the son of Robert Young, a bank-actuary of that city. He received his early education at the Nottingham High School, and from there went to the Royal College of Science, where he remained from 1899 until 1901. He obtained the B.Sc. degree of the University of London and was then appointed lecture-assistant to Prof. Purdie of St. Andrews, a position which he held until 1903.

In 1903, Young was appointed research assistant to Prof. Purdie and lecturer in the University and, until 1907, was engaged in carrying out some important researches with Prof. Purdie. Among these may be noted a paper on the alkylation of rhamnose and one on the optically active forms of alkyl oxysuccinic acid, two important applications of the reaction for the alkylation of hydroxy compounds introduced by Purdie which has proved so fruitful in elucidating the constitution of the sugars. He was awarded the D.Sc. degree of the University of St. Andrews on the results of his research work. From 1907 until 1915 he held the post of lecturer in chemistry at the University of Sheffield, and here, although his duties prevented him from continuing his research work, he proved himself to be an able and effective teacher.

When the late Dr. A. W. Crossley, early in 1916, resigned the secretaryship of the Chemical Warfare Committee in order to take over the control of the then newly established experimental station at Porton, he was moved to recommend Young for the post, for Crossley was a great judge of men, and had recognised Young's special qualifications while acting as external examiner at St. Andrews and Sheffield. From this date until the end of the War, Young fully justified Crossley's choice and carried out the duties of his difficult office with that tact, discretion, and thoroughness which characterised all his work. He endeared himself to all members of the Committee by his willingness to serve and by his innate modesty and unfailing courtesy. When in 1919 there arose the question of the appointment of a technical officer for the Department of Scientific and Industrial Research, the three members of the Committee, who were also members of the Advisory Council of the Department, were unanimous in recommending Young for the new post.

Young served the Department for nearly ten years, and was, at the time of his death, secretary of the Scientific Grants Committee. All those who came in contact with him, both in his official and personal capacities, recognised his true worth. He had a kindly, rather shy, temperament and a very lovable disposition. Self-effacing and modest, he nevertheless held his views strongly and was quick to express them with force when occasion required. He was created an Officer of the British Empire for his War services. He died on Dec. 26 last, after a brief illness, and leaves a widow and two daughters. J. F. T.

WE regret to record the death of Dr. Dawson F. D. Turner at the age of seventy-one years. He was one of the few medical men who took up the study of X-rays in medical work in the real pioneer days. Unfortunately, he suffered from the rays when their dangerous character was scarcely known, but this did not prevent many years of excellent work on his part. He was head of the X-ray department in the Edinburgh Royal Infirmary for nearly twenty-five years, and during this time contributed original papers on the subject of X-rays and medical electricity. His book on the therapeutics of radium was one of the first, if not the first, published in Great Britain. He was a vice-president of the Röntgen Society, and at one time president of the Royal Scottish Society of Arts.

WE regret to announce the following deaths:

Prof. John M. Coulter, professor of botany in the University of Chicago from 1896 until 1925 and a foreign member of the Linnean Society of London, who has been editor of the *Botanical Gazette* since 1875, on Dec. 23, aged seventy-seven years.

Mr. J. S. Diller, who served with the U.S. Geological Survey for forty-one years and was well known for his studies of the geology of the Pacific Coast, on Nov. 13, aged seventy years.

Dr. Alois Kreidl, professor of physiology in the University of Vienna, on Dec. 6, aged sixty-four years.

Prof. F. P. Leavenworth, emeritus professor of astronomy in the University of Minnesota, known for his work in astronomical photography, on Nov. 12, aged seventy years.

Sir Charles Macara, Bart., founder of the International Federation of Master Cotton Spinners' and Manufacturers' Associations and widely known in industrial circles, on Jan. 2, aged eighty-three years.

Prof. E. H. L. Schwarz, professor of geology in Rhodes University College, Grahamstown, South Africa, on Dec. 19, aged forty-five years.

Sir Henry Trueman Wood, secretary from 1879 until 1917 of the Royal Society of Arts, on Jan. 7, aged eighty-three years.

Prof. Alexander Ziwet, professor of mathematics at the University of Michigan since 1888, and an associate editor of the *Bulletin of the Mathematical Society*, on Nov. 18, aged seventy-five years.

News and Views.

THE descriptive statements which have been published from time to time indicate both the nature of the King's illness and the treatment adopted more fully than is possible in the daily bulletins and enable a clear picture of the course of the malady to be formed. The illness began as a streptococcal septicæmia, with later localisation of the infection between the base of the right lung and the diaphragm: such a 'fixation abscess' is of favourable import, since its appearance is usually followed by a lessening of the general infection. Apart from treatment directed towards the maintenance of the patient's strength, including the assimilation of appropriate nourishment, the aim has been to aid the development of the body's defences against the attack of the micro-organisms and to maintain the blood and tissues generally in as nearly normal a condition as possible. Thus the application of ultra-violet rays to the skin in suitable dosage should result in an increase in the bactericidal power of the blood; whilst the organisms in the abscess cavity in the chest can be more directly attacked by the application of antiseptic solutions. For this latter purpose a solution of hypochlorous acid containing active chlorine, which was developed during the War by Carrel and Dakin for the treatment of septic wounds, has been used: its advantages are that it is almost non-toxic to living tissues, including the white cells of the blood which enter the abscess cavity to ingest and destroy the organisms, although acting deleteriously upon the organisms themselves.

IN the early days of the King's illness the presence of the organisms in the blood stream resulted in a definite anæmia, but with the lessening of the infection the number of red blood corpuscles has increased again and a transfusion of blood has not been considered either necessary or advisable. On the other hand, chemical examination of the blood has of late shown a deficiency of calcium, which is being combated by the administration of a salt of this element with parathyroid extract. The parathyroid glands are known to have some control over the calcium metabolism of the body; experimental removal is followed by a fall in the blood calcium, accompanied by the development of muscular spasms known as tetany: administration of an extract of the glands raises the blood calcium and abolishes the symptoms. The extract is effective also in other conditions not obviously connected with disturbance of the parathyroid glands, in which the blood calcium has fallen to a subnormal level. In the present case it is probable that the presence of the abscess in the chest has effected a drain of this element from the blood. Elevation of the blood calcium will also aid in raising the blood pressure, which has fallen below the normal level during the course of the illness. Improvement appears to be taking place slowly, but surely enough to justify the hope that the King will be restored to his people.

THE sixth annual meeting of British Zoologists was held in the rooms of the Zoological Society on Jan. 5, ninety zoologists being present. The meeting discussed the interim report of the Royal Commission on National Museums and Art Galleries, and after a long and interesting discussion passed, unanimously, a resolution "That the Trustees of the British Museum be approached in order to represent the urgency of putting upon an equal and independent basis the direction of the two branches of the British Museum at South Kensington and Bloomsbury." The important research work, not only in academic but also in economic zoology, which is carried out in the Natural History Museum is held by zoologists to justify an autonomy which does not at present exist. The needs of the Museum and the nature of the work carried on in it differ so greatly from those of the library and archæological sections, that the necessity of conducting business through the accounting office at Bloomsbury necessarily involves a hindrance to its work.

THE meeting of British Zoologists also discussed the present shortage of trained zoologists for technical posts. Instances in which it had been impossible to find a suitable applicant for most attractive posts were reported. Mr. S. G. Tallents, the secretary of the Empire Marketing Board, showed that a considerably increased demand for biologists may be expected from the tropical dependencies. The shortage seems to depend on the unwillingness of students, or of their parents, to face the risks of undertaking a career in which the total number of posts is very small in comparison with the openings in such a profession as medicine or even with those available to chemists. The attractiveness of zoology as a career is further decreased by the fact that even the most highly paid zoologists receive a salary which would represent no more than a very modest success in medicine or other professions. In addition, zoological appointments fall to be made at irregular intervals, and are unpredictable. It is thus impossible to ensure a student whose interest is in fisheries research that there will be a post vacant four or five years hence when he finishes his university course. Zoologists of the last generation pursued that science because they felt that it mattered, to them at any rate, more than other things; they trusted to their abilities to gain them a livelihood, even if a poor one. The modern student wishes certainty, a permanent post with a pension. The meeting passed a resolution in favour of the establishment of an association of professional zoologists and appointed a committee to consider the constitution of such a body.

WE fear that the advocates of better and more extended biological teaching in schools will read the recent correspondence on this subject in the *Times* with mixed feelings. The correspondence began with Sir Charles Robertson's comments on Mr. Ormsby-Gore's report of his visit to Malaya, Ceylon, and Java, which is the subject of the leading article in this week's issue. Sir Charles indicates four main causes for the present unsatisfactory position: our urbanised

and industrial outlook; the dominance of chemistry and physics in the school science course; the congested school curriculum; the newness of the subject. He believes that until the situation in the secondary schools is altered, no amount of propaganda by government bodies and no changes in the attitude of the universities will avail in providing the greatly increased number of qualified biologists urgently needed in the Empire. In this he will be fully supported by those who have studied the problem of introducing a proper biological course into the schools. Nevertheless, it is only an incidental reason, great though its material importance undoubtedly is. The real justification is set out, almost alone among those taking part in the correspondence, by the headmaster of Dauntsey School: 'Biology has a spirit and soul as well as a money value.' For the rest, the arguments cover familiar ground. The universities are blamed by some for unwitting obstruction, and are praised by others for encouragement in excess of that warranted by present conditions. Attention is directed to the disparity of income between leading biologists holding official positions, and moderately successful lawyers, doctors, and tradesmen—a contrast which loses much of its point because it applies to physicists and chemists as well, with the exception of a very few in the leading industrial organisations.

WE can only hope that constant ventilation of the subject will help to direct attention to the analysis of the position and the definite recommendations made in two reports, dealing with animal biology in the school curriculum, and science in the school certificate examinations, respectively, which were presented at the Glasgow meeting of the British Association. If any doubt existed as to the urgent need of fully trained biologists in the Empire, it would be removed by Mr. Ormsby-Gore's address on "Developments and Opportunities in the Colonial Empire," given at University College, London, under the auspices of the Association of Scientific Workers. He pointed out that nearly all the non-self-governing colonies have now reached the stage of evolution necessitating the establishment of a whole series of technical services to assist their economic and cultural development. The majority of the non-self-governing colonies lie in or near the tropics, and their resources are almost entirely agricultural. Biologists, specialised in the numerous branches of this science, are urgently needed in the agricultural field and in all branches of medical work. In addition to this perhaps self-evident need, there is the highly significant fact that in the very difficult task of educating the native population the only contacts between the mind of the British teacher and that of the indigenous population are biological. The natives cannot see any benefit in education unless it deals with their ever-present preoccupations—their struggle for existence, the health of themselves, their animals, and crops.

THE Council of the Physical Society has awarded the sixth (1928) Duddell Memorial Medal to Dr. Charles Édouard Guillaume, the Director of the Bureau International des Poids et Mesures, Sèvres. The medal is awarded annually to some one who has contributed to the advancement of knowledge by the invention or design of scientific instruments or by the discovery of material used in their construction. Dr. Guillaume is known to the world for the invention of three metallic alloys of great importance, invar, elinvar, and platinite. Industrially, the last one of the three is much the most important. It is a nickel-iron alloy having approximately the same temperature coefficient of expansion as glass, so that it can be fused into glass and used as the wire for introducing the current into electric incandescent lamps. The wire is frequently covered with a thin coating of copper to which the glass adheres, and in this form the wire is known as 'red platinum.' As about one thousand million lamps are made annually, the saving between the cost of platinum wire, which was the only suitable material formerly available, and the alloy, approximates to £1,000,000 per annum.

THE other two alloys associated with Dr. Guillaume's name are of great scientific importance. Invar, a nickel-steel, discovered in 1896, has practically no temperature coefficient of expansion, so that the length of a surveying tape made of it is almost unaffected by temperature. Its use in accurate surveying work has reduced the time taken to one fiftieth of that required a few years ago. The pendulum rods of all modern first-class clocks are also made of the same material. The third material, elinvar, was invented by Dr. Guillaume for the manufacture of the balance springs of watches. The coefficient of elasticity of elinvar does not change with temperature, so that the control exerted by the spring does not vary with temperature. It is estimated that about five million watches are made annually in which the balance springs are of this material. In his earlier scientific career, Dr. Guillaume did a great deal to develop the accuracy of measurement obtainable with the mercury-in-glass thermometer. His book "Traité pratique de thermométrie de précision," published in 1889, has remained the classic on the subject. Dr. Guillaume has published many papers connected with the standards of metrology, and his name is synonymous with accuracy of measurement. He was appointed Director of the Bureau des Poids et Mesures in 1915, and received the Nobel Prize for physics in 1920.

THERE was an international celebration of Sir J. C. Bose's seventieth birthday on Dec. 1. In India the Maharaja of Nepal, the governors and chancellors of different universities, sent their delegates, and Rabindra Nath Tagore composed a special poem for the occasion. Congratulatory messages were received from many leading representatives of progressive knowledge in Europe; and Romain Rolland, the distinguished man of letters of the Sorbonne, Paris, wrote: "You have incorporated into the Empire of Spirit the new Universe of Life which only yesterday was taken as unconscious, dead and buried in the night." The National Research Institute, Nanking, sent the message that "the world looks to you to lift science into the realm of Spiritual Reality. All Asia

shares in your glory." Sir J. C. Bose in course of his reply, said that he had "for the last forty years worked towards winning for India a recognised place among federation of nations by her contributions for extending boundaries of knowledge. The world is to-day divided into warring hosts threatening the very existence of civilisation. There is only one way to save world-wide ruin, and that is by intellectual co-operation for the common benefit of mankind." At a meeting of the Senate of the University of Calcutta on Dec. 8, a resolution was passed congratulating Sir J. C. Bose on the work he has done for the advancement of science.

IN a paper entitled "Economic Application of Electricity to Low Temperature and Heating Purposes," read before the Institution of Heating and Ventilating Engineers on Jan. 2, Mr. G. Wilkinson described an economic application of electricity for heating purposes by means of a 'change-circuit.' By this means the load factor of supply stations can be increased and domestic electric heating becomes a possibility on cost alone. Mr. Wilkinson said that, assuming an increase in load factor from 25 per cent to 75 per cent, there were available during the year 1927–28 for heating purposes the enormous total of 19,855,701,260 kilowatt-hours at $\frac{1}{3}$ penny. This amount is being increased every day with the growth of the constant voltage supplies. Energy in the form of electricity has the advantage that it can be readily delivered at any point where heat is required, and the expense of pipe transmission and heavy heat losses of transmission are saved. Each floor of a building, and if necessary each radiator or panel, may have its separate storage cylinder which will absorb the constantly varying amount of energy received from the 'change-circuits,' thus forming a heat reserve to be drawn upon at such times and rates as required to maintain uniform temperature under all weather variations. The absence of combustion and the products of combustion enables these cylinders to be placed in positions where any radiation loss is usefully employed, and the whole system lends itself readily to convenient applications not obtainable with any other form of heating.

NOISE, it is becoming realised, is an important and to some extent preventible affliction which civilised and gregarious human beings are called upon to suffer. Although, in a strictly scientific sense, all noise is not harmful, or even unwelcome, the pleasant noises are generally called by some other name. Among the definitely deleterious varieties is undoubtedly that of modern road traffic, and any means of dealing with that part of the nuisance amenable to treatment—provided such means are reasonably economical, fairly efficient, and not unduly inconvenient—are bound to attract the serious consideration of highway engineers, of medical men, and of dwellers in noisy cities. In a paper read by Lieut.-Col. T. H. Chapman at the conference on rubber roadways and floor coverings, held under the auspices of the Institution of the Rubber Industry and the Rubber Growers' Association on Jan. 3, a useful survey of progress in the employment of rubber for this purpose was presented. It is not claimed that rubber is, in every sense, an ideal material, for such would exhibit absolutely no deterioration or wear under usage and weather. Rubber is, however, smooth without being slippery, hard yet resilient, impervious to moisture, dustless, and easily cleaned; it absorbs vibration, diminishes noise, and requires no maintenance; hence rubber goes a long way towards meeting the requirements of the ideal. Whilst granite setts, asphalt, and wood blocks all have their distinctive advantages, there are special areas where the cost of rubber should not be allowed to obscure its obvious merits. The latest examples of rubber paving laid in London are on the approach to Fresh Wharf (London Bridge), in New Bridge Street (Blackfriars), Thurloe Place (South Kensington), and Croydon Road (Anerley); at Edinburgh in Shandwick Place, and at Glasgow in Buchanan Street. Lieut.-Col. Chapman indicated directions in which technical difficulties are still obstructive; at present, for example, rubber cannot be laid and then vulcanised *in situ*, although an advance in the direction of 'carpeting' with vulcanised rubber appears practicable. So far as reduction of noise is concerned, tests in Whitehall showed that, compared with wood paving, the reduction was 30 per cent, that the residual noise was less objectionable, and that vibration was diminished.

RUBBER flooring was discussed at the same conference by Dr. S. S. Pickles. Here the problem is less of a technical than of an educational nature. The reputation of rubber as a floor covering is well established, and despite the somewhat high initial cost, the low price of rubber now affords wider opportunities for its employment. Its shock-absorbing properties and comparative noiselessness are self-evident advantages. It is, moreover, interesting to note that its use in a London church was attended by an improvement in the acoustic properties; rubber flooring thus absorbs sounds already produced. Further, the poor conductivity for heat and electricity, the resistance to abrasion, and the fact that it is waterproof and non-absorbent, all contribute significantly to its claims for a more widespread public and domestic use. Dr. Pickles gave much information concerning the types and properties of rubber floor coverings which should prove of service to an architect desiring to develop flooring schemes in keeping with the character of his structure. Incidentally, he mentioned that he had had under personal observation for nearly twenty years rubber floors in a chemical laboratory and in a power house; both were still in excellent condition as regards wear. When referring to the types of apparatus employed in estimating the suitability of rubber and rubber compositions, and to the need for constant examination and control of products on the part of manufacturers, he said that if a composite plate of rubber and steel is subjected to a sand blast, the steel portion may be worn completely through, leaving the rubber almost unaffected.

THE Institution of Chemical Engineers has decided to institute, in commemoration of the late Lord

Moulton, two awards for papers on chemical engineering subjects. The senior award will consist of a medal in gold, bearing a likeness of Lord Moulton on the obverse, and be awarded for the best paper of the year of a mature character, read before the Institution and published in the *Transactions*. The award will not be confined to members of the Institution. The junior award will consist of a similar medal in silver, with a prize of books to the value of £3, for which graduates and students of the Institution only will be eligible. The award will be made for the best paper of the year communicated to the Institution, and deemed of sufficient merit to be published in the *Transactions*.

IN connexion the World Engineering Congress which will be held at Tokyo on Oct. 29–Nov. 22 by the Kogakkai, or Engineering Society of Japan, and supported by the Japanese Government, a conference of representatives of twenty-three institutions and societies met recently at the Institution of Civil Engineers to consider the best means by which British representation at the congress could be organised. As a result, " The British Committee on the World Engineering Congress in Japan " was formed, having its secretariat and place of meeting provided by the Institution of Civil Engineers. The Committee has as its objects the organisation of a party of British engineers to attend the Congress, and the securing of papers for presentation, and a small executive committee under the chairmanship of Sir Brodie Henderson has been appointed. The Congress will be the first of its kind held in Japan, and it is evident that the Japanese with their usual energy are making every effort to make it worthy of the progress achieved in that country. It is therefore the earnest wish of the Committee to awaken the interest and enlist the support of engineers, so as to ensure adequate British representation at the Congress by the presence of a large party of delegates and by the presentation of a number of papers.

RADIO advices from the non-magnetic yacht *Carnegie*, which left Balboa, Canal Zone, on Oct. 25 for the first passage in the Pacific of her Cruise VII, state she arrived at Easter Island on Dec. 6, four days ahead of her schedule, with all well on board and after a fine trip with ideal weather conditions and no storms. The observational work during the passage from Balboa to Easter Island included 58 magnetic stations, 10 ocean and tow-net stations, 70 sonic depth-determinations, 24 pilot-balloon flights, 6 evaporation series, 23 biological stations, 25 days of photographic records of atmospheric electric potential gradient, and four 24-hour runs of other atmospheric electric elements. Because of a slight leak which developed in the depth-finder oscillator (mounted on the keel of the vessel), echoes for soundings have been obtained through firing of a shotgun at the end of a pipe extending 20 feet below the surface ; the results with this emergency arrangement have checked well with depths determined by wire and pressure.

IN commemoration of the centenary of the birth of John Innes, the council of the John Innes Horticultural Institution, Merton, is holding a conference on polyploidy as a source of species and horticultural varieties, on Saturday, Jan. 19, at 2.30 P.M. All who are interested are invited to attend ; tea will be provided.

ON Tuesday next, Jan. 15, at 5.15, Dr. F. A. Freeth will begin a course of two lectures at the Royal Institution on critical phenomena in saturated solutions, and on Thursday, Jan. 17, Major Gordon Home delivers the first of two lectures on Roman London. The Friday evening discourse on Jan. 18, to be delivered by Sir William Bragg, will describe further progress in crystal analysis, and, on Jan. 25, Prof. A. C. Seward will speak on the vegetation of Greenland.

IN connexion with our article entitled " A Neglected Aspect of Scientific Research " (NATURE, Dec. 15, p. 913), it is of interest to know that the British Society for International Bibliography has recently been formed to deal with questions of classification. It is a daughter society of the Institut International de Bibliographie and has its headquarters at the Science Library, South Kensington, London, S.W.7, where the Brussels Decimal Classification is used. The honorary secretary is Mrs. S. M. Tritton.

RECENT issues of the *Daily Science News Bulletin* (by Science Service, Washington, D.C.) direct attention to the great epidemic of influenza which is spreading widely over the United States, and has also reached Canada. Cases of ordinary so-called influenza usually occur mostly in January and February, while ' epidemic influenza ' occurs at any and all times of the year. This suggests that the present outbreak is one of epidemic influenza, the last visitation of which was in 1918.

MR. J. T. CUNNINGHAM writes to point out a mistake in the use of terms which occurs in a review by Prof. Karl Pearson in NATURE of Dec. 22, 1928, p. 955, column 2, line 7. Although the meaning of the passage was probably clear to most readers, Prof. Pearson is glad to have an opportunity of correcting the slip. What he intended to say was that "the lack of anterior pigment as judged by a lens is asserted to indicate that the individual has a truly blue eye ; and will produce gametes carrying a recessive unit factor for blue. Two such lens-tested individuals will produce only true blue-eyed children."

THE latest catalogue of Messrs. Dulau and Co., Ltd., 32 Old Bond Street, W.1, is No. 163. It gives the titles of upwards of 900 second-hand books of botanical interest, classified under the following headings : Herbals, early gardening, fruit culture, etc., prior to the year 1700 ; horticulture, gardening, fruit culture, etc., after the year 1700 ; botany, botanical travels, agriculture, etc., and cryptogams, plant pathology, etc.

MESSRS OGILVY AND CO., 20 Mortimer Street, London, W.1, have sent us a catalogue of shop-soiled and second-hand instruments and apparatus, mainly microscopical. Messrs Ogilvy have decided

to discontinue their second-hand department and in consequence are disposing of their second-hand stock, which includes a large and varied selection of microscopes and accessories and microscope preparations.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A technical assistant at a Naval Experimental Establishment—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (Jan. 12). A head of the Department of Pharmacy in the Bradford Technical College—The Principal, Technical College, Bradford (Jan. 15). A lecturer in physics and electrical engineering at the Handsworth Technical College—The Chief Education Officer, Education Office, Council House, Birmingham (Jan. 19). A science master at the Lawrence Royal Military School, Sanawar, India—The Secretary to the High Commissioner for India (General Department), 42 Grosvenor Gardens, London, S.W.1 (Jan. 19). A lecturer in civil engineering and building trades work in the Engineering Department of the Portsmouth Municipal College—The Secretary, Municipal College, Portsmouth (Jan. 25). A junior scientific officer under the Directorate of Scientific Research, Air Ministry, for research in applied physics, chiefly in connexion with aeronautical instruments—The Chief Superintendent, R.A.E., South Farnborough, Hants (Jan. 26). An investigator at the Mines Department Testing Station at Sheffield—The Under-Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1 (Jan. 28). A principal of the Government Technical School, Accra, Gold Coast—C.A. [T.], The Secretary, Board of Education, Whitehall, S.W.1. Scottish candidates —[T.], The Secretary, Scottish Education Department, Whitehall, S.W.1 (Jan. 28). An engineering assistant in the County Surveyor's Department of the Wilts County Council—The Clerk of the County Council, County Offices, Trowbridge (Jan. 28). A research assistant (botanical) and a research assistant (an entomologist) in the department of plant pathology of the Albert Agricultural College, University College, Dublin, for the investigation of virus diseases of plants—The Secretary, University College, Dublin (Jan. 31). A lecturer in physics in the University of Western Australia—The Agent-General for Western Australia, Savoy House, 115 Strand, W.C.2 (Jan. 31).

Our Astronomical Column.

ELONGATION OF MERCURY.—The easterly elongations of Mercury in spring are the most convenient and favourable of the year for observing this planet. They occur in 1929 on Jan. 22 and May 15, and the former will afford some excellent opportunities for viewing the planet from about Jan. 14 until Jan. 28. On Jan. 16 Mercury will set about $1\frac{1}{4}$ hr. after the sun, on Jan. 26 about $1\frac{3}{4}$ hr. later. It will be brighter before the date of elongation than afterwards, so that observations should be attempted during the third week of the month. It will be moving in an easterly direction amongst the southern stars, but at the close of January will appear stationary in the western region of Aquarius.

The times of setting and apparent brilliancy of the planet will be as follow :

	Mercury Sets (G.M T.).	Apparent Stellar Lustre.		Mercury Sets (G.M.T.).	Apparent Stellar Lustre.
Jan. 14.	17^h 38^m	−0·74	Jan. 22.	18^h 12^m	−0·34
,, 16.	17 47	−0·70	,, 24.	12 16	−0·18
,, 18.	17 57	−0·62	,, 26.	18 18	−0·02
,, 20.	18 6	−0·50			

The brightness of the planet will therefore exceed that of such stars as Vega and Arcturus, and with a clear sky there should be little difficulty in detecting it.

REAL AND FICTITIOUS METEOR RADIANTS.—V. A. Maltzev of Leningrad contributes a paper on this subject to *Astr. Nachr.*, 5604. He quotes Dr. C. P. Olivier as saying that he was prepared to find that half the radiants in his catalogue did not correspond with real meteor streams. The rule adopted was that a radiant needed at least four meteors on the same night passing through a circle 2° in diameter to establish it.

Experiments were made at Leningrad by letting pins fall at random on a horizontal board graduated to correspond with a region of the sky extending over 90° in right ascension and 75° in declination. The point of the pin denotes the direction of motion. It would seem that very accurate horizontality of the board is necessary, otherwise the pins have a tendency to roll about their points. The conclusions drawn from the experiments are that more than half the published radiants are fictitious, and that more than 4 meteors through a 2° circle are required to establish a radiant. With a total of 100 meteors observed, it is considered that 11 meteors through a 2° circle are required. As the total number of meteors observed becomes less, the number required for a radiant slowly diminishes, being 8 when the total is 50, and 5 when it is 10. But 4 meteors will still suffice when the same radiant is confirmed by observations in other years on the same calendar date.

SAN LUIS CATALOGUE OF 15333 STARS.—The Carnegie Institution of Washington has just published this very useful catalogue. The late Prof. Lewis Boss felt the need of modern observations for many of the stars south of the equator in his Preliminary General Catalogue, and arranged that the Albany transit circle should be set up at San Luis, Argentina, so that the northern and southern observations should be obtained under as nearly as possible the same conditions, the observers being also the same. Prof. Tucker was in charge of the expedition, which worked so energetically that 87,000 observations were secured between April 1909 and January 1911. A series of photometric observations then commenced, which terminated in February 1913.

The reductions have been carried through with great care, the refractions being carefully studied. Stars were not observed both by reflection and directly at the same transit ; at Greenwich also it has been found advisable to abandon such double observations ; the second one being made in a hurry, after swinging the telescope through a large angle, was found to be subject to systematic errors. A comparison of both the Albany and San Luis catalogues with the P.G.C. shows that the two former agree very well with each other, but the systematic difference from the P.G.C. reaches 0·4″ in the neighbourhood of 20° N. Decl. There are many faint stars in the catalogue, some of mag. 10·4. Their positions are given for 1910·0 ; there is no discussion of proper motions.

Research Items.

PREFERENTIAL MARRIAGE IN SOUTH AFRICA.—In *Africa*, vol. 1, No. 4, Werner Erselen studies the conditions of marriage among the various races of South Africa in order to show that the property-family marriage entails a number of obligations on the interested parties. When marriage depends, as it does here, on a bride price, the desire of a young man for marriage, entailing payment of property which he has not yet had an opportunity to acquire, ceases to be a matter for the individual and brings in the family. The bride-price is provided by the family. This among the Bantu is in the form of cattle, their only wealth. The types of marriage are cross-cousin marriage, when the children of brothers and sisters intermarry, but the marriage of the children of sisters is forbidden; the sororate, when a man marries his deceased wife's sister, but it is the third and not the second sister who may thus be acquired; and marriage by inheritance when a man's wives are appropriated by his heirs—the principal heir being the eldest son, his own mother going to a younger brother of the deceased. These forms of marriage with their variations in detail are the natural result of a system of contract between two families based on the exchange of women for cattle or other property of equivalent value. Among the Xosa, where the levirate does not exist, a widow may either marry a stranger who repays the cattle originally paid with a discount for each child already born, and retained by the husband's family, or she has to stay with her husband's people. In the latter case children born as the result of intercourse with non-related men are looked upon as the legitimate children of her deceased husband.

THE IRON AGE IN ITALY.—In *Man* for December, Dr. Randall-MacIver discusses recent theory on the absolute chronology of the Early Iron Age in Italy, basing his argument on views recently put forward by Prof. Sundwall. This author holds (1) that the Villanovans were driven from Central Europe by climate change in the ninth century B.C.; and (2) that no painted pottery of Greek origin could come into Italy except via Cumae, and therefore sites on which it occurs must be later than 750 B.C. Against this view Dr. Randall-MacIver argues that, whatever the date of the climatic crisis, it does not fix the date of the migration, which may have taken place long before the final phase of hardship was attained. Further, other motives for migration may have been operative. As regards the second point, it is entirely disproved by recent excavations. The Greek pottery of Canale belongs to the eighth and ninth century, and is directly connected with the Dipylon schools. The sites, then, on which the pottery are found are therefore earlier, not later, than 750 B.C. Dr. Randall-MacIver's own dating places the First Benacci period at 1000 B.C. or earlier, Ducati brings it down to the ninth or eighth century. Dr. Randall-MacIver here makes two modifications. He accepts the rejection of his dating of 850 B.C. for the Warrior's Tomb at Corneto, though he thinks it cannot be later than the first half of the eighth century, and he now puts some of the Vetulonian tombs so late as 650 B.C.

ORIGIN OF THE FAUNA OF LAKE BAIKAL.—Lake Baikal in Siberia has always been considered to have a highly peculiar fauna, with a number of forms not occurring anywhere else. Recent investigations of fresh-water faunas of the northern hemisphere tend, however, to disprove that view, since many groups and species of animals which were regarded as endemic to Lake Baikal have been found elsewhere. Thus the genus of sponges *Baikalospongia* was found in a lake near the river Yenisei; amongst the Oligochæta, 13 species of the genus *Lamprodrilus* are peculiar to Baikal, but four more are now known in Europe and Siberia; a representative of another Baikal genus, *Teleuscolex*, has been discovered recently in Lake Okhrida in Macedonia; the genus *Propappus* (fam. Enchytræidæ) was known only from Baikal, but one species has been described from Elba and found afterwards in the Volga and other Russian rivers, as well as in Lake Baikal itself; amongst the Crustacea, the genus *Echinogammarus* is represented in Lake Baikal by 39 species, and there are four more species, namely, one in Lake Okhrida, one in the Faroë Islands, one in Tripolitania, and one in Spain, France, and Germany. The Baikal molluscan genus *Choanomphalus* is also represented in Lake Okhrida. An endemic Baikal diatom, *Gomphonema quadripunctata*, has been recently found in the Khanka Sea, near Vladivostok. Thus the idea of a very high endemism of the Baikal fauna seems to require a revision; the main endemic elements of the fauna are all of fresh-water origin, while there are no relics of an ancient marine fauna, as has been suggested by some authors. These facts lead L. S. Berg (*Comptes rendus*, Acad. Sci., Leningrad, No. 22; 1928) to conclude that the fauna of Lake Baikal has been derived from an upper tertiary fauna of fresh-water, or brackish-water, basins.

EMBRYOLOGY OF *STYLOPS*.—J. Noskiewicz and G. Poluszyński record (*Bull. Int. Acad. Polonaise Sc.*, Ser. B; 1928) observations on the embryology of the Strepsipteran *Stylops*. The egg is poor in yolk and the cleavage total and equal. During the fourth or fifth cleavage a nucleus is given off from one of the blastomeres into the central yolk mass, which is clearly delimited from the blastomeres and does not divide although its nucleus undergoes two divisions synchronous with those of the blastomeres. After the seventh cleavage the embryo consists of 120 or 124 blastomeres and a quadrinucleate yolk syncytium. About the fifth or sixth cleavage the embryo begins to be two layered and the end result of the cleavage is a morula in which the yolk sphere is peripheral. This stage is transient, for the cells soon assume a radial arrangement in a single layer with a peripheral yolk mass and a central cavity filled with a granular material secreted by the cells. The cells which lie under the yolk invaginate and thus a double-layered cup results. In the cavity of the cup is the yolk mass, the inner layer is the germ layer and the outer is the envelope, apparently equivalent to amnion + serosa of other insects. The germinal disc begins to elongate and the embryo becomes rolled at both ends, and stomodæum and proctodæum are formed. Cells proliferated from the end of the stomodæum gradually surround the yolk and form the mid-gut, which at a later stage has a tubular connexion with the fore-gut, but the proctodæum remains blind. The genital cells are differentiated moderately late as an unpaired mass of cells near the proctodæum.

FEEDING OF *AUTOLYTUS*.—Yo K. Okado (*Quart. Jour. Micr. Sci.*, Oct. 1928) describes the method of feeding of *Autolytus edwardsi*, as observed at Plymouth. This polychaet attacks the tentacles and upper portions of the hydranths of *Obelia*, cutting them off with the toothed tip of the chitinous tube of the protruded pharynx. The pumping action of the proventriculus, which has a valve at each end, causes the food to be

sucked through the pharynx and driven through the ventriculus (reduced in *Autolytus*) into the intestine. The pulsations of the proventriculus are about 120 per minute. The muscular elements of the proventriculus are strong columns, which extend radially from the lining epithelium, and slender semi-annular bands. Each radial column represents a single cell the major part of which consists of undifferentiated protoplasm (with one nucleus), on the periphery of which are the fibrils. In each fibril are four contractile zones, three internodes, and two insertion parts. The contractile zones only stain with hæmatoxylin, and may be compared with the anisotropic bands of the striated muscle of arthropods.

INDIAN HYDRACARINA.—A number of fresh-water mites have already been recorded from Ceylon and parts of India. Dr. C. Walter ("Zur Kenntnis der Mikrofauna von British Indien. II. Hydracarina," *Records of the Indian Museum*, vol. 30, pt. 1, 1928) describes a number of new species inhabiting marshy regions from a collection made by Dr. P. A. Chappuis for the most part from the Punjab and neighbourhood. All but one of these belong to known genera, the new genus *Testudacarus* being founded for one species based on one female only. Nearly half of the species recorded, however, are new. One of these, *Alurus scutelliformis*, has the hind legs armed with peculiar blade-like spines somewhat resembling the chelæ in certain annelids. Only one male and one nymph of this species were found. The paper is well illustrated by line drawings and there is a valuable list in tabular form showing the distribution of all the Hydracarina known from the Indo-Australian region, with a good survey of literature on the subject.

DEVELOPMENT OF *LEPTOSYNAPTA INHÆRENS*.—S. Runnström, in *Bergens Museums Årbok*, Heft 1, 1927, has an important paper dealing with the development of *Leptosynapta inhærens*. The biology is discussed. During the reproductive period the germ cells were shed between 3 and 6 P.M. daily for about a month. There were indications of periodicity in the reproductive activity. An account is given of cleavage, and a detailed study is made of the development of the mesoderm, nervous system, mesenchyme, and spicules. A barrel-shaped larva is produced. Comparison is made between this development and that of other Holothurians and consideration is given to the symmetry of the class and to the modifications of the *Synaptidæ*.

GENETICS OF THE DUTCH RABBIT.—Since 1920 an extended controversy has been taking place between Prof. Punnett and Prof. Castle regarding the genetics of the 'Dutch' rabbit. Prof. Punnett now returns to the charge armed with further breeding data (*Jour. of Genetics*, vol. 20, No. 2). These rabbits show a range of colour-marking from almost pure white to entirely black. Punnett interprets the condition as due to a major factor P producing the higher grades of pigmentation (and incidentally preventing *heterochromidia iridis*) and two minor factors S and T which are cumulative in effect, showing more pigmentation in the homozygous than the heterozygous condition. The typical Dutch pattern would be represented by $ppSSTT$. Another minor factor N occurs in most self-coloured breeds. Thus the whole colour series is explained by one major factor and three modifying factors. In place of P, Prof. Castle postulates three multiple allelomorphs, Du for self-colour, du_d for Dark Dutch and du_w for White Dutch, with certain modifying factors in addition. Castle also believes he has found linkage between Dutch pattern and long Angora hair, which Punnett believes is unproved. The English pattern has been shown by Castle to be closely linked with the Dutch; English × Dutch giving 3 : 1 ratios in F_2 except for rare cross-overs. The English rabbit has a factor for self-colour *plus* an inhibitory factor I, hence $IIPP$ with certain minor factors. By matings with White Dutch, conclusions are drawn by Punnett which support his interpretations. The special value of this work lies in the analysis of what appears phenotypically as a more or less continuous series of colour patterns.

POST-EOCENE MOLLUSCA OF NORTH-WESTERN INDIA.—Nearly three years ago we directed attention (NATURE, Feb. 13, 1926, p. 246) to the publication of the first part of "Descriptions of Mollusca from the Post-Eocene Tertiary Formations of North-western India," by the late Dr. E. Vredenburg. Now, after inevitable delays, the second part has appeared under the editorship of Mr. H. M. Lahiri (*Mem. Geol. Surv. India*, vol. 50, pt. 2). It deals with the remainder of the Gastropoda and the whole of the Pelecypoda from the stratigraphical divisions distinguished by Blanford as the Nari, Gaj, and Mekran. Close on two hundred species, many being new, are carefully described, some in great detail, and figured from the author's photographs on 22 plates executed by the Survey in most admirable manner. There is a good index to the whole volume at the end.

SOUTHERN RHODESIAN MINES.—The Geological Survey of Southern Rhodesia has published in its *Bulletin* No. 13 a number of miscellaneous reports by Mr. F. E. Keep, State mining geologist. There are nine of these reports, five of them, namely, those on the Glen Hume and Glen Brook Gold Blocks, the Cactus mine, both in Gwelo district, the Lone Tree mine in Salisbury district, the Belvedere mine in the Belingwe district, the claims of the Parthenon Syndicate in the Hartley district being essentially gold mines; whilst there are also reports on the Belingwe antimony claims, upon the Copper Duke and Golden Duke mines in the Hartley district, upon Devitt's asbestos claims in the Selukwe district, and upon the Neardy mine in the Makoni district, which appears to carry copper and good lead ores. Apparently none of these mines is yet in a highly developed condition, and the reports, though extremely valuable for those locally interested in mining, cannot be said to be of any notable general importance.

SUPPORT OF UNDERGROUND WORKINGS.—The Safety in Mines Research Board has just issued Paper No. 45 dealing with the support of underground workings in certain of the more southern coalfields of England, including North and South Staffordshire, Cannock Chase, Shropshire, Leicestershire and South Derbyshire, Warwickshire, Forest of Dean, Bristol and Somerset, and Kent. The report gives a quantity of useful information, particularly in respect of the use of steel supports, the value of which is slowly beginning to be appreciated. A useful feature is a glossary of the mining terms employed; these differ so much in different parts of England that their inclusion is a distinct advantage, more particularly for those whose experience has lain in the other coalfields of Britain. There is a very useful summary of recommendations, some of which are deserving of the widest possible application, because a recommendation such as that "it is a good practice to keep in each district of the mine at least one day's supply of all lengths of timber in use," is a recommendation that might well be extended to all the coalfields of Great Britain, and the same may be said of many of the other recommendations; it is interesting to find that the authors of the report strongly recommend self-adjusting steel props both

for economy and safety, and also state that "when once steel arches are tried their use is generally extended." There is no doubt that the Committee of the Safety in Mines Research Board, which is studying the question of the support of underground workings, is one of the most useful that the Board has yet set up.

MADAGASCAR AND ITS OIL LANDS.—The mention of oil possibilities of certain countries conjures up all kinds of technical controversy, and it must be said that Madagascar, despite the Indo-Asiatic affinity attributed to it by Dr. A. Wade recently, prompts many conflicting impressions. If we admit that "geologically the island is an extension of the fundamental gneissic platform of Africa," which scarcely anyone would be prepared to gainsay, it is a little difficult to reconcile "every other point of view" with this Indo-Asiatic perspective drawn by that author during the course of his paper read before the Institution of Petroleum Technologists on Dec. 11 last. Most of the previous work on Madagascar has emanated from French writers, and it is certainly useful to have a modern English version by one who has spent considerable time in studying the geology of that island. But we feel that a more appropriate title for the paper would have been "The Geology of Madagascar," for the author scarcely makes out an encouraging case for its oil possibilities; he is, in fact, indicatively cautious in this connexion, his concluding remark being: "None can say that the island is devoid of possibilities in this direction." In so far as oil is concerned, seepages and tar sands occur at Triassic horizons; these overlie Permian beds with characteristic *Glossopteris* flora, in turn resting on the archæan platform. The whole sequence, in fact, is strongly reminiscent of south and south-east African stratigraphy, equally of parts of Asia, but scarcely of the oil-bearing regions of that continent. Most of the trials for oil seem to have been unsuccessful; prompted by the Pechelbronn operations, French engineers even had the idea of 'mining' some of the oil sands, but, unfortunately, there existed practically no pressure which would cause flowage, as the rocks were near the surface. Our impression is that Madagascar provides excellent territory for geological study, but that commercial possibilities of oil are somewhat remote.

CANADIAN FUELS.—The Mines Branch of the Canada Department of Mines has recently issued its report of "Investigation of Fuels and Fuel Testing for the year 1926" (Ottawa: F. A. Acland). The report indicates activities designed to promote the more efficient utilisation of fuels, accumulation of analytical data as to present and potential fuel resources, and actual experimental work to discover methods of exploiting fuels in the future. There is a draft of instruction for the proper burning of various fuels currently used in the domestic furnace, which requires a technique more exacting than the open grate. The analytical work has merely a local interest, but the study of the distillation of oil shales and the treatment of the Alberta bitumen sands has a wider interest. The crude bitumen extracted from the sand was in the form of a stubborn emulsion which was successfully resolved. It was shown that this bitumen formed promising stock for cracking by the Dubbs and Cross processes for the preparation of gasoline. This information is interesting, although the present low prices of crude mineral oil is a bar to development of such processes.

THE CORONA VOLTMETER.—It is well known that the maximum value of the potential difference between two spherical electrodes at the instant of the disruptive discharge can be computed with an accuracy of about one per cent, provided that the potentials of the spheres at the instant of the discharge are equal and opposite. This is one of the standard methods used by electrical engineers for measuring very high voltages. A more accurate method is by means of the corona voltmeter, the principle of which was first employed by Prof. J. B. Whitehead, of Johns Hopkins University. If two perfectly clean concentric metallic cylinders have a voltage applied between them, and if this voltage be gradually increased, then at a definite value the inner cylinder begins to emit light at its surface, ionisation can be detected and a characteristic sound can be heard. The beginning of breakdown can be detected by noticing any of these phenomena. A very thorough experimental study of the corona voltmeter by H. B. Brooks and F. M. Defandorf is published in the October number of the *Journal of the Bureau of Standards*. They find that except in noisy surroundings the aural detection method can be advantageously employed. Although a motor generator set was running in their laboratory, yet by using aeroplane headset telephones with a resistance coupled amplifier, they had no difficulty in making accurate measurements. Spark-over in a corona voltmeter must not be permitted. With aural detection the noise made is deafening, and the spark is injurious to the inner cylinder. The experiments show that when air at atmospheric pressure is used between the cylinders, then the ratio of their radii should not be less than twenty. For commercial work the corona voltmeter as at present constituted seems to be too complicated. Its accuracy, however, being in the neighbourhood of 5 in 10,000, leaves little to be desired.

FREQUENCY CONTROL BY QUARTZ OSCILLATORS.—In the United States, where there are very many broadcasting stations, great care has to be exercised in controlling the frequencies of the radio or carrier waves which they emit so as to avoid interference between them. When interference takes place, a high-pitched whistle which may spoil the programme is heard by the listeners. The Federal Radio Commission arranges so that the frequencies between any two stations always differ by more than 10,000 cycles. The difference frequency nominally, therefore, is not less than 10,000 cycles per second, and this 'beat' note is unobjectionable even if it could be heard. Few radio receivers could amplify, and fewer loud speakers could reproduce this note. In practice, however, it is very difficult to control the regulation sufficiently accurately to avoid beat notes. In the *Bell Laboratories Record* for September, a description is given of the principle of a device used by the Western Electric Co. to regulate the frequencies of the radio waves by means of quartz oscillators. The frequency of these oscillators depends on their thickness and their temperature. The variation of the period of vibration with temperature can be either positive or negative, depending on the cut of the crystal, and varies in amount from about 30 to 80 cycles per million per degree centigrade change in temperature. The crystal is ground until the desired frequency is approximately correct. The final adjustment is done by controlling the temperature at which the crystal operates. In practice the temperature of the crystal is maintained constant whatever the temperature of the room. The crystal is enclosed in a heat insulated box and the temperature of the interior is controlled by thermostatic means, the heating circuit being opened and closed by a vacuum relay. The frequency of a radio transmitter controlled thermally in this way is stated to be constant within a few parts in a million.

The South Africa Meeting of the British Association.

ARRANGEMENTS are now actively in hand for the meeting of the British Association in South Africa, in Cape Town and Johannesburg, next July and August, under the presidency of Sir Thomas Holland, rector of the Imperial College of Science and Technology. The following sectional presidents have been appointed: Section A (Mathematical and Physical Sciences), Right Hon. Lord Rayleigh; Section B (Chemistry), Prof. G. Barger; Section C (Geology), Sir Albert Kitson; Section D (Zoology), Prof. D. M. S. Watson; Section E (Geography), Brigadier E. M. Jack; Section F (Economics), Prof. Henry Clay; Section G (Engineering), Prof. F. C. Lea; Section H (Anthropology), Mr. Henry Balfour; Section I (Physiology), Prof. W. E. Dixon; Section J (Psychology), Mr. F. C. Bartlett; Section K (Botany), Prof. A. C. Seward; Section L (Education), Dr. C. W. Kimmins; Section M (Agriculture), Sir Robert Greig.

Among the many subjects which are already under consideration for lectures and discussions it is probable that the relation between science and industry will take an important place, following upon the subject of Sir William Bragg's presidential address at last year's meeting in Glasgow. It is contemplated that discussions on this topic should be initiated at Cape Town and continued at Johannesburg by representatives in the principal departments of science concerned. A special programme is being arranged for geological members, in order that they may co-operate with the International Geological Congress which will be meeting in Pretoria concurrently with the Association in Johannesburg; and the agricultural members will be afforded opportunity for meetings with their colleagues in the Pan-African Agricultural and Veterinary Congress, which also will be sitting in Pretoria at the same time.

After the meetings the majority of the visiting members, who are expected to number upwards of 400, will divide into three main parties; each of these will visit the Victoria Falls, and two will afterwards make extended journeys through the Union territory, visiting the eastern Transvaal and Lourenço Marques, in Portuguese East Africa, and terminating their journeys at Durban and Cape Town, respectively. The third main party will probably proceed from the Victoria Falls to Beira, visiting en route the ruins at Great Zimbabwe, where it is hoped that Miss Caton-Thompson will have brought to a successful issue the investigation of the ancient remains which she is about to undertake at the instance of the Association.

The sectional organising committees held their usual joint meetings at King's College, London, on Jan. 4, when a number of important subjects were brought under consideration for joint meetings of various sections in South Africa. Among these was a general discussion on the conception of life, which it was proposed should be opened by General Smuts. Other discussions are expected to deal with problems of special interest to South Africa, such as those connected with deep mine ventilation and with the relation of dust to miners' diseases. The geologists, zoologists, and botanists expect to be associated in a discussion on Gondwanaland. Educational problems to be discussed include psychological tests in relation to education and vocational guidance, and the teaching of geography, both of which are understood to be of special interest to South African educationists at the present time. A discussion on vitamins is contemplated between the chemical and physiological sections.

The South African Association for the Advancement of Science, which initiated and forwarded the invitation to the British Association and, through an executive committee, is undertaking the arrangements in South Africa in co-operation with the Travel and Tourist Branch of the South African Railways, has issued special invitations to certain distinguished Dutch and other foreign scientific representatives. of whom the following have accepted: Prof. E. J. Cohen, Prof. W. de Sitter, Prof. G. A. F. Molengraaf, Prof. R. Casimir, Prof. O. Abel, M. l'Abbé Breuil, Prof. C. Dragoni, and Prof. A. S. Hitchcock

Science Masters' Association.

CAMBRIDGE MEETING.

THE twenty-ninth annual meeting of the Science Masters' Association was held at Cambridge on Jan. 2–5. The members were accommodated partly in Trinity College, partly in Gonville and Caius. The deputy vice-chancellor, master of Sidney Sussex College, heartily welcomed the Association to Cambridge. The president—Prof. A. C. Seward, master of Downing College—delivered his presidential address on "The Flora of the Carboniferous Period."

As is usual on these occasions, when the Association goes to one of the university towns, many topics which do not appear in the programme were discussed informally. Prof. Seward broached one of these in the preface to his address, namely, the need for more botanists. There has probably never been a time when the demand for trained men in all branches of science has been either so great or so varied as it is to-day. The staple product, namely, mental ability, is in the schools in quality and quantity sufficient to meet all demands; the willingness to develop it in the best possible way is also there, but somehow the available talent is not being so economically distributed as both schoolmasters and university teachers would wish. There are too many potential chemists, not enough biologists, and extremely few geologists.

The pressing need of the moment is biologists, and especially pure botanists, and what makes matters worse in this branch is that the already inadequate supply is being depleted to some extent by the claims of forestry, which naturally encroaches more on botany than on zoology.

"It would be foolish," said Prof. Seward, in his opening remarks to more than four hundred science masters, "not to seize this exceptional opportunity of asking for sympathetic co-operation in an endeavour to meet a very pressing need. In recent years it has been impossible to satisfy demands from Government Departments and from various other quarters for men qualified to fill administrative and research posts requiring more than an elementary acquaintance with botany. At Cambridge we have plenty of men who take botany as one of three subjects in the first part of the Natural Science Tripos, but there is a shortage of men of first-rate ability who choose botany as the one subject in the second part of the Tripos.

"I have recently circulated a memorandum to tutors and directors of studies drawing attention to the great increase, during the last few years, in the number of well-paid and attractive posts in the Dominions, the Colonies, and at home, which cannot be satisfactorily filled because of the lack of suitable candidates. May I entreat my colleagues who advise

boys on the selection of subjects at the university to assist, not so much the Cambridge Botany School as the Empire as a whole, by encouraging promising pupils to consider the possibility of making an acquaintance with botany as an alternative to choosing what, to many, would be a more familiar and therefore an easier course—the further study of chemistry, physics, and mathematics ?

"This request is made partly because, in my opinion, a man who takes a degree in science should have some knowledge of a biological subject, but primarily because I am convinced of the vital importance of turning out men who can supply one of the greatest needs of the present day by devoting themselves to the investigation of problems which lie at the root of our national prosperity. There are, no doubt, many boys whose mental chords are more responsive to the calls of mathematics, physics, or chemistry than to those of biology : the trouble is a disinclination on the part of some schoolmasters to admit the probability that not a few of their pupils who have shown themselves to be competent students on the physics side might, given an opportunity, discover that biology is their destiny. The safe course at the university, it may be said, is a continuation of that followed successfully at school. I recall a Spanish saying : 'Go with God, Your Grace, and may nothing new happen.' On the other hand, it is perhaps desirable to encourage self-determination, to give all a chance of experiencing the joy of entering a new world, the thrill of a novel quest."

Prof. Seward also put in a plea for a little more geology, an extremely modest plea considering the importance of the subject and the fascination that it has for many boys. "I dare not suggest the addition of geology to an already overburdened curriculum, though I cannot help thinking that more effort might be made to bring boys into touch with this branch of natural knowledge, either by devoting part of a general elementary course in science to geological talks, or, in suitable districts, by encouraging boys to spend some of their free time, if they have any, in making observations for themselves, in collecting fossils—a by no means contemptible occupation—or by studying the more obvious phenomena connected with erosion and rock-building which provide clues to the interpretation of the documents from which geological history is compiled."

A little more autonomy in school certificate and matriculation examinations, or even a little more elasticity in examinations, would do a great deal towards equalising matters. University authorities are apt to blame advanced courses in schools, but the trouble begins with the school certificate, which is also the first statutory examination of a boy's university career. If he gets credit in chemistry and physics in the school certificate, he is entitled to think he has done something in those subjects and he is reluctant to make a fresh start for the higher certificate ; consequently, he does (as he sometimes puts it) chemistry and physics again. When he gets to the university, he is still more reluctant to strike out on entirely new lines.

When the Science Masters' Association meets, as it does, in alternate years at one of the universities—old or new—the members get what is in reality a short but intensive refresher course, relieved by very pleasant social intercourse. University professors and lecturers are astonishingly generous in providing most stimulating lectures, the laboratories and museums are all thrown open, visits to works and attractive demonstrations are arranged. The latest useful devices for aiding science masters in their work and the newest books are brought to their notice in the manufacturers' and publishers' exhibition. It is difficult to appraise the value of conferences, because they vary so much both in utility and in achievement, but whatever may be said in mild disparagement of the conference habit—the 'talker feast,' as our American colleagues put it—there is no doubt that these meetings of the Science Masters' Association are most stimulating and a powerful antidote to that bane of the schoolmaster's work—stagnation.

The next meeting of the Association will be held in London, in January 1930, under the presidency of Prof. James C. Philip, professor of physical chemistry in the Imperial College of Science and Technology.

Whales Landed in Scotland.

PROF. D'ARCY W. THOMPSON has written a most interesting account of the whales landed at the Scottish whaling stations during the years 1908–14 and 1920–27 (*Fishery Board for Scotland: Scientific Investigations*, 1928, No. 3), including a detailed examination of all the records, illustrated by sketch maps showing the place of capture, and by tables and diagrams, as well as a full bibliography of references to the species.

The old Scottish industry was almost at an end when in 1903 the harpoon-gun was introduced from Norway and gave a new impetus to whaling. The harpoon-gun was used in Ireland a hundred years before its re-invention by Captain Svend Foyn about 1865. It is apparently, however, not the harpoon-gun alone which has made the modern whaling industry, but the gun used with the explosive bullet.

A system of licences was introduced in 1908, and full records with measurements are kept of all whales captured. Thus a large amount of valuable information is available on which the present paper is based. 6817 whales were landed in Shetland and Harris from 1908 to 1927 (excluding the years of the War, and 1919 and 1921, when no whaling was conducted). Seven species are represented, the Common Finner, *Balænoptera musculus*, being the commonest, the Bottlenose, *Hyperodon rostratus*, the rarest. In between in order of frequency come the Sei-whale, *Balænoptera borealis*; the Blue whale, *B. Sibbaldi*; the Sperm whale, *Physeta macrocephalus*; the Nordcaper, *Balæna biscayensis*; and the Humpback, *Megaptera longimana*.

Of these the Nordcaper or 'Sarde,' the whale of the old Basque fishery, is one of the most interesting. For some time it was thought to be extinct, but although never taken in numbers, 69 individuals, 35 males and 34 females, have been captured since 1908, nearly all of which have been landed at the whaling station at Bunaveneader and caught within an area lying to the west and south-west of the Hebrides and beyond St. Kilda. Most of these were taken in 1908 and 1909, and it is shown that there are very definite fluctuations in their occurrence, apparently dependent on variations in Gulf Stream water. In those years when the Atlantic overflow to the north-east is strongest these whales are scarce and vice versa, probably owing to their tendency to linger on the coasts of Britain when there is little Gulf Stream current to carry them northwards.

75 Sperm whales are recorded, all but one being males. They do not breed in Scottish waters, and it is thought that these were young bulls which had

been driven out of the herd. It is a remarkable fact that the Sperm whales caught in 1911 (when this species was exceptionally numerous) were all very fat, whilst those caught in 1909 and 1912 were very lean, and the Nordcapers caught in 1909 and 1912 showed the same leanness; and yet the diet of the Sperm whale is mainly cuttlefishes, and that of the Nordcaper consists of the smaller planktonic organisms.

University and Educational Intelligence.

CAMBRIDGE.—A bequest of the value of about £250,000 from the late Mr. John Humphrey Plummer, of Southport, is announced. The money is to be governed by trustees and is for the endowment of two chairs for the promotion of modern scientific research. No details are as yet available as to the conditions governing the trust.

LONDON.—The following courses of free public lectures, without tickets, are announced: "Fatigue," by G. P. Crowden, at University College, on Jan. 14, 21, and 28, at 5; "The Physiology of Reproduction," by Dr. A. S. Parkes, at University College, on Jan. 16, 23, 30, and Feb. 6, 13, and 20, at 5; "The Chemistry of Some Natural Drugs," by Dr. H. R. Ing, at University College, on Jan. 17, 24, 31, Feb. 7, 14, and 21, at 5; "Comparative Physiology," by C. F. Pantin, at University College, on Jan. 18, 25, Feb. 1, 8, 15, 22, Mar. 1, 8, 15, and 22, at 5; "Some Applications of Physical Chemistry to Steel Manufacture," by Dr. A. McCance, at the Imperial College of Science—Royal School of Mines, on Jan. 23, 24, 30, and 31, at 5.30; "Cytology in Relation to Physiological Processes," by Dr. R. J. Ludford, at University College, on Jan. 24, 31, Feb. 7, 14, 21, and 28, at 5; "The Current Work of the Biometric and Eugenics Laboratories [University College]," by Prof. Karl Pearson and others, at University College, on Jan. 29, Feb. 5, 12, 19, 26, and Mar. 5, at 5.30.

MORE than a hundred bibliographies of various subjects have now been issued by the National Book Council, 3 Henrietta Street, London, W.C.2. These lists of books do not profess to be exhaustive, but each is prepared under the auspices of a body competent to express an opinion on the subject with which a particular list deals. One of the latest lists (price 2*d*.) contains the titles of recommended books on popular science, or introductory to the various branches of science, and is compiled by Mr. J. B. Clark, late headmaster of George Heriot's School, and approved by the National Home-reading Union. The list is classified by subjects, and publisher, date, and price are given for each volume. It should be a valuable guide to the general reader who wishes to keep in touch with the progress of modern science.

A HARVARD-YENCHENG Institute of Chinese Studies is to be opened under the supervision of nine directors representing Harvard and Yencheng (Peking) Universities and the estate of the late Charles M. Hall of Niagara Falls, New York, who provided an endowment of two million dollars for it. The work of the Institute, which will be carried on at both universities, will include research in Chinese history, art, literature, philosophy, and religion, and special attention will be paid to the study of the Chinese language as a key to understanding the history and civilisation of China. There are already some fourteen hundred Chinese students in the United States, and numerous scholarships tenable in the United States are provided by the Chinese Educational Mission, while large sums are spent in promoting study and research by Americans in China. The new Institute will obviously strengthen the intellectual ties between the two countries.

Calendar of Patent Records.

January 14, 1822.—The lawyer's wig claims its share of the inventor's attention. On Jan. 14, 1822, there was granted to H. W. Ravenscroft, of Lincoln's Inn, peruke maker, a patent for his "forensic wig, the curls of which are constructed on a principle to supersede the necessity of frizzing, curling, or using hard pomatum; and for forming the curls in a way not to be uncurled; and also for the tails of the wig not to require tying in dressing, and further the impossibility of any person untying them."

January 15, 1820.—During the first hundred years of their existence, pianos, like spinets and harpsichords, were constructed entirely of wood, though the advantages of being able to use thicker and heavier strings had induced many attempts to introduce iron into the frames. William Allen, a tuner, and James Thom, the foreman, at Stodart's, one of the leading piano-makers in London, were the first to devise a satisfactory solution to the problem, and a patent was granted to them for their iron-frame construction on Jan. 15, 1820. The patent rights were at once bought by Stodart's and a great step forward towards the modern piano was made.

January 15, 1910.—The unsplinterable glass known as 'triplex glass,' which consists of two sheets of glass united by sticking between them a sheet of celluloid softened by a solvent such as acetone and subjecting them to considerable pressure, was invented by Édouard Benedictus of Paris. His French patent was applied for in August 1909, and the printed specification describing the invention was published on Jan. 15, 1910. The British patent was applied for a few days later and antedated to the date of the French application.

January 18, 1799.—The continuous papermaking machine was invented by Louis Robert, a mechanic in the employ of Didot St. Leger, paper manufacturer of Essones, France, a French patent being granted to him on Jan. 18, 1799. The French patent rights were assigned to Didot, but the practical application and development of the invention were due to the Fourdriniers of London, who had acquired the English rights from the patentee, John Gamble. Although an Act of Parliament was obtained extending the life of the patent to the year 1822, the patent was hotly contested and was finally set aside by the courts on a technical flaw, and the Fourdriniers lost not only their royalties but also the very considerable sum of money they had spent in perfecting the invention.

January 20, 1818.—The great tunnel enterprises of recent years were made possible by the invention of the tunnel boring-shield by Marc Isambard Brunel, the patent for which is dated Jan. 20, 1818. Brunel's shield—the general principles of which are the same as those of the shields in use to-day—was employed for the first time in 1825 for the construction of the Thames tunnel at Rotherhithe, which after long delays due to financial difficulties was finally completed and opened to the public in 1843. No other shield tunnel was built until 1869.

January 20, 1820.—Labour-saving devices have generally had their origin in the United States, and it was here that the standardisation of parts in gunmaking and their manufacture on the interchangeable system was worked out and fully developed. One of the principle inventors in this field was Thomas Blanchard, a descendant from a Huguenot family which settled in Boston in the seventeenth century. The United States patent for his lathe for turning gunstocks was granted on Jan. 20, 1820, and such was its importance that it was twice extended by Act of Congress, first in 1834 and again in 1848.

Societies and Academies.

LONDON.

Geological Society, Dec. 5.—K. S. Sandford: The erratic rocks and the age of the southern limit of glaciation in the Oxford district. The Plateau Drift around Oxford contains rocks brought from long distances: from Scandinavia, Scotland, East Anglia, the Midlands, and, most surprising of all, from Devon and Cornwall. The Drift entered the district through the Cotswold escarpment by gaps which the northern tributaries of the Upper Thames occupy. There is no evidence of glacial erosion of the district within the scarp, though a few patches of Drift are recognised as Boulder Clay. It is not suggested that heavy glacier-ice was the vehicle in every instance: for example, the material from the south-west was most probably carried on detached shore-ice drifting up the Bristol Channel. This material lends support to the view that the southern midlands in particular were submerged to a considerable depth. The material, however introduced, was 'graded' or redeposited in terraces up to 350 feet above the recent rivers, this process being subsequent to, and distinct from, the introduction of the Drift into the district. The erratics are believed to have been assembled under glacial conditions, evidently over a long interval of time, early in the Pleistocene Period. Within the district a threefold glacial sequence is now established. The first, the subject of this paper, was the maximum glaciation of the southern midlands and of early Pleistocene age. During the other two the district was an ice-free land-area, between the glaciers of the eastern counties and of Wales. The Oxford district being ice-free during these later glacial episodes, the conditions which then prevailed are faithfully recorded in the contemporary fluviatile deposits and surface-changes. The chronological sequence is given.

Royal Meteorological Society, Dec. 19.—L. H. G. Dines: The Dines float barograph. The instrument designed by the late Mr. W. H. Dines about twenty years ago, which has been in use at the observatories of the Meteorological Office for a number of years, is a pen-recording barograph of which the leading feature is the care taken to reduce friction in the mechanism. The record will indicate barometric oscillations of amplitudes down to one or two tenths of a millibar.—J. Glasspoole: The distribution of the average seasonal rainfall over Europe. In western Europe there is abundant rain at all seasons, with a minimum in summer and a maximum in winter. In the Mediterranean region there is very little rainfall at all during the summer, while there is generally a preponderance at this season in central Europe. In the three months June–August only one-fiftieth of the average annual rain falls in the south of Spain, while more than half the annual amount falls in the same period in north-eastern Russia.

PARIS.

Academy of Sciences, Dec. 3.—Camille Gutton was elected *Correspondant* for the Section of Physics, and Louis Léger for the Section of Anatomy and Zoology. —Long: A property which appears to belong to prime numbers.—Herbert Ory: The equation $x^n = a$, where a is a square-determinant of the second order.—B Hostinsky: The probabilities relating to the position of a sphere with fixed centre.—C. Lurquin: A limit of probability in the Bienaymé-Tchebycheff sense.—Vladimir Bernstein: Some theorems on the growth of holomorph functions and the series of Dirichlet.—Paul Lévy: The symbolic calculus of Dirac.—F. H. van den Dungen: The approximate calculation of the fundamental numbers.—A. Zygmund: Conjugated functions.—Alexandre Rajchman: A class of functions with limited variation.—Henri Bénard: Alternating vortices (in liquids) due to knife-edge obstacles.—J. Haag: Extension of the theory of Saint-Venant to elastic wires of any form.—R. de Fleury: Aluminium pistons. It has been noted that the substitution of aluminium pistons for iron pistons in internal combustion engines leads to a marked increase in the wear of the cylinder. The possible causes of this are discussed.—Thadée Peczalski: The kinetic theory of adsorption.—Mlle. Marie Kosinska: The Joule-Thomson effect and the internal friction of fluids.—Vasilesco Karpen: The Van der Waal's equation and the principles of thermodynamics. The Maxwell-Clausius relation and the formula of Clapeyron deduced from this equation.—Edgar Pierre Tawil: A new mode of developing electricity by torsion in quartz crystals.—Albert Arnulf: An optical method of localisation of polished surfaces, and its application to the measurement of radii of curvature.—V. Posejpal: The fluorescence of benzene and its infra-red absorption.—H. Barjot: Utilisable natural energy. In regions within the Arctic Circle the atmospheric temperature may be from $-25°$ C. to $-40°$ C., whilst ice-covered lakes have water immediately under the ice layer at 0° C. A heat engine with ammonia, carbon dioxide, or sulphur dioxide as working liquid could be worked over this range and used as a source of energy.—Albert and Marcel Gosselin: Constitution and thermochemistry.—Charles Prevost: Some new phenomena of tautomerism in the allyl series. Study of the phenomena of tautomerism between compounds of the types $C_2H_5 \cdot CHX \cdot CH : CH_2$ and $C_2H_5 \cdot CH : CH \cdot CH_2X$.—J. Orcel: Remarks on the measurement of the reflecting power of opaque minerals and of highly refractive transparent minerals. A completion of an earlier paper on the same subject with additions on the choice of standard minerals and on the calculation of ω, the angle of maximum rotation of the plane of polarisation of the incident light.—Paul Gaubert: The action of heat and of the loss of water on the optical properties of heulandite. An attempt is made to determine the separate effects of rise of temperature, loss of water, and optical anomalies.—Maurice Blumenthal: The existence of the Malaga Betic in the region of Grenada.—A. Demay: The prolongation of the Cevennes strata on the western border of the Saint-Etienne coal basin.—Pierre Viennot: New geological observations in the Labourd (Basse-Pyrénées).—Jacques Bourcart and Guy Le Villain: The fauna of the Cambrian limestones of Sidi Mouça d'Agloa, near Tiznit (South Morocco).—Gustave Rivière and Georges Pichard: The fertilisation of soils poor in lime. Comparative trials with various carbonates. A description of experiments on the effects of the addition of carbonates of calcium, magnesium, sodium, and potassium to soils, equimolecular proportions being employed. In each case the yield of oats was increased, the most marked effect being produced by sodium carbonate, which appeared to act as a true manure.—A. Mordvilko: New contribution to the study of anolocycly in the Aphides. *Forda formicaria* and its anocyclic form.—Alphonse Labbé: The experimental production of conjunctive tissue by the amæbocytes in *Doris tuberculata*.—J. J. Thomasset: An attempt at the classification of the varieties of dentine in fishes.—André Boivin: Contribution to the study of the chromic-sulphuric acid oxidation of carbonaceous substances. A general method for the micro-estimation of carbon in the wet way. The modifications suggested are a temperature

of 100° C. for the moist combustion and a means of burning the carbon monoxide always produced.—E. Brumpt: The identity of the genera *Grahamella* and *Bartonella*.—Georges Blanc and J Caminopetros: Experiments made in Greece on the mode of transmission of dengue. Attention is directed to the fact that the word 'dengue' has been applied to two separate diseases. The mosquito *Stegomyia* is infected by the disease and can transmit it in the usual way; mosquitoes of the genus *Culex* do not pass on the infection by stinging.—Et. Burnet, P. Durand, and D. Olmer: Attempts at the transmission of Marseilles exanthematic fever by lice. Attempts to infect apes through the medium of lice gave negative results.

Official Publications Received.

BRITISH.

Madras Agricultural Department. Year Book, 1927. Pp. ii+48+5 plates. 10 annas. Report on the Operations of the Department of Agriculture, Madras Presidency, for the Year 1927–28. Pp. ii+103+4+6 plates. 1 rupee. Bulletin No. 92: Mosaic Disease of Sugar Cane. By Rudolph D. Anstead. Pp. 13+2 plates. 6 annas Bulletin No. 93: Cultivation of Plantains on Wet Lands in the Godavari Delta. Pp. ii+8+1 plate. 2 annas. (Madras: Government Press.)

South Australia: Department of Mines. Mining Review for the Half-Year ended June 30th, 1928. (No. 48.) Pp. 70+9 plates. (Adelaide: Harrison Weir.)

Tide Tables for the Eastern Coasts of Canada for the Year 1929: including the River and Gulf of St. Lawrence, the Atlantic Coast, the Bay of Fundy, Northumberland and Cabot Straits; and Information on Currents; in addition to Tide Tables for New York and Boston, U.S.A. (Thirty-third Year of Issue.) Pp. 90. (Ottawa: F. A. Acland.)

Transactions of the Geological Society of Glasgow. Vol. 18, Part 2, 1927–1928. Pp. 247-360. (Glasgow.) 7s. 6d.

City of Leicester Museum and Art Gallery. Twenty-fourth Report to the City Council, 1st April 1927 to 31st March 1928. Pp. 24. (Leicester.)

London School of Hygiene and Tropical Medicine. Report on the Work of the School for the year ended July 31st, 1928. Pp. 32. (London.)

FOREIGN.

University of Illinois Engineering Experiment Station. Bulletin No. 185: A Study of the Failure of Concrete under combined Compressive Stresses. By Prof. Frank E. Richart, Anton Brandtzaeg and Rex L. Brown. Pp. 104. 55 cents. Bulletin No. 186: Heat Transfer in Ammonia Condensers, Part 2. By Prof. Alonzo P. Kratz, Prof. Horace J. Macintire and Richard E. Gould. Pp. 28. 20 cents. (Urbana, Ill.)

New York Academy of Sciences. Scientific Survey of Porto Rico and the Virgin Islands. Vol. 10, Part 1: Amphibians and Land Reptiles of Porto Rico, with a List of those reported from the Virgin Islands. By Karl Patterson Schmidt. Pp. 160+4 plates. (New York City.)

Department of the Interior: Bureau of Education. Bulletin, 1928, No. 14: Land-Grant Colleges and Universities, Year ended June 30, 1927. By Walter J. Greenleaf. Pp. v+77. (Washington, D.C.: Government Printing Office) 15 cents.

Japanese Journal of Physics: Transactions and Abstracts. Vol. 5, No. 1. Pp. 66+14+2 plates. (Tokyo: National Research Council of Japan.)

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 80. Land Shells of Tortuga Island, Haiti, and a new Haitian Oleacina, by Henry A. Pilsbry and Edward G. Vanatta, Review of the Species of Lucidella belonging to the Subgenus Poeniella (Helicinidae) of Haiti and Santo Domingo, by Henry A. Pilsbry. Pp. 475-482+plate 27. (Philadelphia, Pa.)

CATALOGUES, ETC

Rare Books. (Catalogue No. 23.) Pp. 58. (Newcastle-on-Tyne: William H. Robinson.)

Calendar for 1929. (Newcastle-on-Tyne C. A. Parsons and Co., Ltd.)

Nickel Steels, Series A, No. 2. The Properties and Applications of Invar and related Alloys. By C. E. Guillaume. Translated by R. Rengert Pp. 8. (London: The Bureau of Information on Nickel, Ltd.)

Calendar for 1929. (London: Cambridge Instrument Co., Ltd.)

Calendar for 1929. (London: *The Chemical Trade Journal.*)

Récentes publications médicales. Pp. 64. (Paris: Masson et Cie.)

Diary of Societies.

FRIDAY, JANUARY 11.

ROYAL ASTRONOMICAL SOCIETY, at 5.—T. Royds: A Very High Prominence on Nov 19, 1928—J. M. Baldwin: Alignment Chart Connecting Position Angle and Distance of the Apex of the Sun's Way and Galactic Co-ordinates with Equatorial Co-ordinates.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—L. C. Wharton: Dialect Developments.

MALACOLOGICAL SOCIETY OF LONDON (in Zoological Department, University College), at 6.—E. Ashby: Taxonomic Value of Characters in the Order Polyplacophora.—C. Oldham: *Cepæa hortensis* Mull. and *Arianta arbustorum* L. on Blown Sand.—Dr. H. Engel: *Aplysia* (*Tethys*) *dactylomela* Rang, a Circumtropic Species.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in Mining Institute, Newcastle-upon-Tyne), at 6.—W. J. Drummond: Coal used in its Raw State—Dr. W. T. K. Braunholz: Fuels obtained by the Treatment of Coal.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—J. A. H. Lloyd: Telephone Repeaters.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at Engineers' Club, Manchester), at 7.—Dr. F. C. Wood: Recent Progress in the Study of the Chemical Reactions of Cellulose.—N. S. A. Humphries: The Efficiency of the Present Day Finishing Stenter.—F. Schofield: A New Oxygen Carrier for Dyeing and Printing Processes.—Dr. G. N. Burkhardt and H. Wood: The Nitro-Aryl-Sulphuric Acids and their Reduction Products.

JUNIOR INSTITUTION OF ENGINEERS, at 7 30.—F. E. Webb: Developments in Spraying Apparatus.

BLACKBURN TEXTILE SOCIETY (at Blackburn Technical College), at 7.30.—Dr. P. Bean: The Dyeing of Artificial Silk.

KEIGHLEY TEXTILE SOCIETY (at Kiosk Café, Keighley), at 7.30.—Lecture on Artificial Silk.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Thomas' Cafe, Swansea), at 7.30.—A. Grounds: Preparation of Coal for the Market.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Royal Society of Arts), at 8.—Prof. B. P. Haigh: The Relative Safeties of Mild and High-Tensile Alloyed Steels under Alternating and Pulsating Stresses.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—M. L. Hepburn: An Attempt to Classify (Pathologically) the Various Fundus Pictures in Diseases of the Choroid.—M. S. Mayou: Juvenile Glaucoma.

MONDAY, JANUARY 14.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Col. Sir Gerald Lenox-Conyngham: The Cambridge Pendulums for Gravity Survey.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: A Sketch of the Present State of Knowledge regarding the Evolution of the Brain in Higher Primates.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Centre) (at Queen's Hotel, Birmingham), at 7.—Dr. F. W. Lanchester: Coil Ignition.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Loughborough College), at 7.—E. C. Thompson: Purchasing.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College), at 7.—Capt. J. M. Donaldson, J G. Hines. and others: Discussion on The Anticipation of Demand, and the Economic Selection, Provision, and Layout of Plant.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—Major A. Jenkin and others: Discussion on Electric Trolley Omnibuses

CERAMIC SOCIETY (at North Staffordshire Technical College, Stoke-on-Trent), at 7.30.—G. W. S. Brewer: Pre-wheel Pottery—Descriptive of Iron Age Remains from Cleeve Hill, Cheltenham—K. Silk and N. D. Wood: The Comparative Effects on Earthenware Slip of Varying Soda-silica Ratios in Silicate of Soda.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (Associate Members' and Graduates' Branch) (London and District) (at Borough Polytechnic), at 7.30.—A. T. Henly: Timber Drying and Seasoning.

HUNTERIAN SOCIETY OF LONDON, at 7.30.—Prof. Putti: Lecture.

INSTITUTE OF METALS (Scottish Local Section) (at Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow), at 7.30.—A. Spittle: Recent Developments in the Manufacture of Condenser Tubes.

INSTITUTE OF BREWING (London Section) (at Charing Cross Hotel).—J. Stewart: The Malting Barleys of 1928.

TUESDAY, JANUARY 15.

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.—Dr. F. Parkes Weber: Endocrine Tumours.—Dr. O. Leyton: How can we Decide that a Case of Glycosuria Should be Treated?

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. F. A. Freeth: Critical Phenomena in Saturated Solutions (I).

ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.

MINERALOGICAL SOCIETY (at Geological Society of London), at 5.30.—Prof. A. Holmes and Dr. H. F. Harwood: The Tholeite Dikes of the North of England.—A. Russell: On the Occurrence of Gold at Hope's Nose, Torquay, Devonshire.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at Derby Technical College), at 6.45.—F. H. Rosencrants: Practice and Progress in Combustion of Coal as applied to Steam Generation.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7—J L. Carr: Recent Developments in Electricity Meters, with Particular Reference to those for Special Purposes.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. E. B. Wright: Rock Climbing in the English Lake District.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (Associate Members' and Graduates' Branch) (Manchester and District) (at Milton Hall, Manchester), at 7.—L. Barton: Ventilation of Institutions and Public Buildings.

INSTITUTE OF METALS (North-East Coast Local Section) (at Armstrong College, Newcastle-upon-Tyne), at 7 30.—R. Dowson: Some Aspects of Steam Turbine Development and Application

BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES (at Royal Society of Arts), at 8.15.—Roger Fry: Representation in Art (Lecture).

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Prof. R. R. Gates: Studies of Eskimos and Indians in the Canadian Arctic.

INSTITUTION OF MECHANICAL ENGINEERS (Swansea Branch).—J. W. Burr: The Electrification of a Small Railway.

WEDNESDAY, JANUARY 16.

SOCIETY OF GLASS TECHNOLOGY (at Manchester), at 2.30.

ROYAL SOCIETY OF MEDICINE (Surgery: Sub-Section of Proctology), at 5.—Clinical Pathological Meeting.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Growth of the Human Brain, and a Discussion as to the Significance of its Mass.

INSTITUTION OF CIVIL ENGINEERS (Informal Meeting), at 6.—H. H. Dalrymple-Hay. Merits and Demerits of Alternative Methods of taking Water for Modern Power-Stations from Tidal Waters.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (jointly with Liverpool Engineering Society) (at Liverpool), at 7.

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Section) (at Cleveland Technical Institute, Middlesbrough), at 7.—S. G. Marston, D. G. F. Drummond, and others: Informal Discussion on The I.E.E. Wiring Regulations.
SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (jointly with Institute of Chemistry), at 7.15.—W. P. Dreeper: Artificial Silk (Lecture).
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Newcastle-upon-Tyne), at 7.15.—H. Caird, W. S. Paulin, and others: Discussion on Steam Engine Machinery versus Diesel Machinery.
INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—T. W. Sampson: The Electrical Engineer and Medical Science.
JUNIOR INSTITUTION OF ENGINEERS (Sheffield and District Local Section) (at Cutlers' Hall, Sheffield), at 7.30.—Lt.-Col. J. T. C. Moore-Brabazon: Early Aviation.
INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—A. Spittle: Recent Developments in the Manufacture of Condenser Tubes.
TEXTILE INSTITUTE (Yorkshire Section, jointly with Halifax Textile Society) (at White Swan Hotel, Halifax), at 7.30.—A. Saville: Some New Factors in Industry.
ROYAL METEOROLOGICAL SOCIETY (Annual General Meeting), at 7.40.—Presentation of the Buchan Prize to Dr. Harold Jeffreys.—Sir Richard Gregory: Amateurs as Pioneers (Presidential Address).
ROYAL SOCIETY OF ARTS, at 8.—Prof. C. R. Darling: The Domestic Smoke Problem—a Practical Solution.
ROYAL MICROSCOPICAL SOCIETY (Annual General Meeting), at 8.—J. E. Barnard: Some Aspects of Ultra-Violet Microscopy (Presidential Address).
LEICESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemistry Section) (at College of Technology, Leicester), at 8.—J. P. O'Callaghan: Present-day Methods of Water Softening.
ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (at Northampton Polytechnic Institute), at 8.15.—D. J. Macnaughtan and R. A. F. Hammond: The Progress of Nickel Deposition in Recent Years.
SOCIETY OF CHEMICAL INDUSTRY (Newcastle Section) (at Armstrong College).—S. A. Wikner: Tar Distillation.
SOCIETY OF CHEMICAL INDUSTRY (Nottingham Section).—F. G. Conyers: The Distillation of Wood.
INSTITUTE OF CHEMISTRY (Huddersfield Section).—Spiropyans and the Formation of Coloured Ions.

THURSDAY, JANUARY 17.

ROYAL SOCIETY, at 4.30.—Prof. A. S. Eddington: The Charge of an Electron.—R. H. Fowler: The Thermionic Emission Constant A.—J. A. Gaunt: The Triplets of Helium.—G. Temple: The Tensorial Form of Dirac's Wave Equations.—*Papers to be read in title only*:—Prof. H. M. Macdonald: The Reflexion and Transmission of Electric Waves at the Interface between two Transparent Media.—D. K. Bhattacharyya: On the Analysis of the First Spark Spectrum of Sulphur.—C. W. Gibby, C. C. Tanner, and Prof. I. Masson: The Pressure of Gaseous Mixtures (II.).—J. S. Foster: Effect of Combined Electric and Magnetic Fields on the Helium Spectrum.—R. W. B. Pearse: The Ultra-Violet Spectrum of Magnesium Hydride (I.).—J. S. Foster and W. Rowles: Patterns and Paschen-Back Analogue in the Stark Effect for Neon.—J. K. L. MacDonald: Stark Effect in a Violet Region of the Secondary Spectrum of Helium.—J. S. Foster and M. L. Chalk: Relative Intensities of Stark Components in Hydrogen.—J. Chariton and G. A. Lea: (*a*) Some Experiments concerning the Counting of Scintillations produced by Alpha-Particles. Part I. (*b*) Some Experiments concerning the Counting of Scintillations produced by Alpha-Particles. Part II. The Determination of the Efficiency of Transformation of Kinetic Energy of the α-Particles into Radiant Energy. (*c*) Some Experiments concerning the Counting of Scintillations produced by Alpha-Particles. Part III. Practical Applications.—O. R. Baldwin: The Relativity Theory of Divergent Waves.—Dr. G. W. C. Kaye and W. F. Higgins: The Thermal Conductivity of Solid and Liquid Sulphur.—S. Barrett and C. P. Stein: On Bromine Chloride.
LINNEAN SOCIETY OF LONDON, at 5.—Dr. G. Enderlein: Die Copeognathen-Fauna der Seychellen.—S. Maulik: Chrysomelid Coleoptera of the Subfamilies Eumolpinæ, Galerucinæ, and Halticinæ from the Islands of the Western Indian Ocean.—Prof. F. E. Lloyd: The Resistance of the Door of the *Utricularia* Traps to Water Pressure.—Dr. A. B. Rendle: A Remarkable Subterranean Orchid from West Australia.
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Gordon Home: Roman London (I.).
BIOCHEMICAL SOCIETY—UNIVERSITY OF BIRMINGHAM (at Birmingham University), at 5.30.—Prof. A. R. Ling: Presidential Address.
INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.
INSTITUTE OF METALS (Birmingham Local Section) (at Engineers' Club, Birmingham), at 7.—A. J. Dale: Refractories for Use in Metallurgical Furnaces.
BATLEY AND DISTRICT TEXTILE SOCIETY (at Batley Public Library), at 7.30.—W. F. Vickers: Oils and Wool.
INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Section) (jointly with Society of Chemical Industry, Edinburgh and East of Scotland Section) (at North British Station Hotel, Edinburgh), at 7.30.—Dr. J. D. M. Ross: X-Ray Analysis of Crystals.
SOCIETY OF DYERS AND COLOURISTS (Midlands Section) (at Leicester Technical College), at 7.30.—A. J. Hall: Swelling of Fibres.
OPTICAL SOCIETY (at Imperial College of Science), at 7.30.—E. F. Fincham: The Function of the Lens Capsule in the Accommodation of the Eye.—Dr. D. S. Perfect: A Double Reflection Level.—T. Smith, Dr. J. S. Anderson, and L. C. Cordle: Photographs of Reflexion Caustics.
CHEMICAL SOCIETY, at 8.—A. H. Dickins, W. E. Hugh, and G. A. R. Kon: The Chemistry of the Three-carbon System. Part XX. Cyclo Pentylideneacetone and Cyclopentylidenemethylethyl Ketone.—H. D. K. Drew: Non-existence of Isomerism among the Dialkyl Telluronium Dihalides.—C. S. Gibson and J. L. Simonsen: Indian Turpentine from *Pinus longifolia* Roxb. Part V. The Oxidation of d-Δ^3-carene with Beckmann's Chromic Acid Mixture.
ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.), at 8.15.—Dr. E. Hindle: An Experimental Study of Yellow Fever.
BRITISH INSTITUTE OF RADIOLOGY, at 8.30.
SOCIETY OF DYERS AND COLOURISTS (West Riding Section) (at Bradford).—Prof. H. E. Fierz-David.
INSTITUTION OF MECHANICAL ENGINEERS (Birmingham Branch).—Informal Discussion.
INSTITUTION OF MECHANICAL ENGINEERS (Manchester Branch).—Dr. E. G. Ritchie: Steam Storage.
NELSON TEXTILE SOCIETY (at Nelson).—J. Smeaton: The Testing of Textile Materials and the Work undertaken by the Manchester Chamber of Commerce Testing House.

FRIDAY, JANUARY 18.

TEXTILE INSTITUTE (Lancashire Section) (at Manchester), at 1.15.—J. P. O'Callaghan: Water Softening for the Textile Industries.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Present State of Knowledge concerning the Cortical Areas of the Human Brain.
SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at Liverpool University), at 6.—C. Gordon Smith: Common Salt.
INSTITUTION OF MECHANICAL ENGINEERS, at 6.—J. G. Weir: Modern Feed-Water Circuits.
INSTITUTION OF CHEMICAL ENGINEERS, (at Institution of Civil Engineers), at 6.30.—Prof. J. W. Cobb: The Reactivities of Solid Carbon in Fuel Processes (Lecture).
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—M. O. Dell: Some Recent Prints from the Pyrenees.
GLASGOW SOCIETY OF DYERS (at 7 Gordon Street, Glasgow), at 7.15.—A. J. Hall: The Action of Swelling Agents on Artificial Silk.
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—J. F. Petree: Notes on the Fitting and Operation of Michell Bearings.
OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Milton Hall, Manchester), at 7.30.—Dr. J. J. Fox: The Examination of Paints.
ROYAL SOCIETY OF MEDICINE (Pathology, Surgery, and Obstetrics Sections), at 8.—Special Discussion on Post-operative Thrombosis. Openers: W. H. Evans (Pathology), D. H. Patey (Surgery), V. Bonney (Obstetrics).
ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—C. T. Holland: Epiphyseal Injuries of the Wrist Joint.—Dr. R. S. Patterson: Some Factors Influencing Epiphyseal Growth and Union.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir William Bragg: Further Progress in Crystal Analysis.
SOCIETY OF DYERS AND COLOURISTS (Manchester Section).—Dr. S. G. Barker: The Standardisation of Fastness of Dyestuffs on Dyed Fabrics.
TODMORDEN TEXTILE SOCIETY (at Todmorden).—H. P. Curtis: Cloth Testing and Examination from the Manchester Man's View.

SATURDAY, JANUARY 19.

GEOLOGISTS' ASSOCIATION (at Museum of Practical Geology, Jermyn Street), at 2.30.—Dr. R. Crookall: Demonstration of Coals, their Composition and Origin.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. E. Cammaerts: Flemish and Belgian Art (I.): The Portrait.

PUBLIC LECTURES.

MONDAY, JANUARY 14.

UNIVERSITY COLLEGE, at 5.—G. P. Crowden: Fatigue. (Succeeding Lectures on Jan. 21 and 28.)
EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—R. T. Parkhurst: Poultry Research.

TUESDAY, JANUARY 15.

GRESHAM COLLEGE, at 6.—A. R. Hinks: Distinguished Stars. (Succeeding Lectures on Jan. 16, 17, and 18.)

WEDNESDAY, JANUARY 16.

UNIVERSITY COLLEGE, at 5.—Dr. A. S. Parkes: The Physiology of Reproduction. (Succeeding Lectures on Jan. 23, 30, Feb. 6, 13, and 20.)

THURSDAY, JANUARY 17.

UNIVERSITY COLLEGE, at 5.—Dr. H. R. Ing: The Chemistry of some Natural Drugs. (Succeeding Lectures on Jan. 24, 31, Feb. 7, 14, and 21.)
BEDFORD COLLEGE FOR WOMEN, at 5.15.—T. A. Joyce: The Architecture of Central and South America.

FRIDAY, JANUARY 18.

UNIVERSITY COLLEGE, at 5.—C. F. Pantin: Comparative Physiology. (Succeeding Lectures on Jan. 25, Feb. 1, 8, 15, 22, Mar. 1, 8, 15, and 22.)

SATURDAY, JANUARY 19.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—D. Martin Roberts: London through the Ages.

CONFERENCE.

FRIDAY, JANUARY 11.

ROTHAMSTED EXPERIMENTAL STATION, at 11.15 A.M.—The Hertfordshire Agricultural Situation. Can it be Improved? Chairman: Sir John Russell.
R. J. Thompson: Agricultural Production in Hertfordshire.
A. W. Street: Poultry as an Adjunct to the Farm (including Marketing of Eggs).
D. Crawford: Labour-saving Machinery as a Means of Lowering Costs of Production.
F. J. Prewett: Improved Methods of Milk Marketing by Pools and otherwise.
R. R. Enfield: The Ministry of Agriculture's Short Term Credit Scheme.
G. Dallas: Agricultural Labour in Hertfordshire.
J. Hunter Smith: The Place of the Oaklands Institute in the County Agriculture.

SATURDAY, JANUARY 19, 1929.

CONTENTS.

Editorial and Publishing Offices:
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What is Life?

OUR knowledge of the past history of life upon earth, obtained from studies both of the earth's crust and of the organisms which are found inhabiting it at the present time, suggests that living beings developed from non-living material, the organic from the inorganic. But the conditions on the surface of this globe must have been widely different from those which obtain at the present day, and the question whether life can arise from the non-living to-day is still unanswered. It is generally held that the evidence indicates that a living organism can only arise from another living being, experiments favouring the view that spontaneous generation does occur having failed to withstand the strictest tests of criticism.

The answer to this question, however, depends on the definition of the terms 'living' and 'non-living'; at first sight the distinction between the two appears sharp and unmistakable, but a little consideration shows that certain living organisms show many analogies with non-living material, and that on the borderland of life it may be difficult to say with certainty whether any given material is 'alive' or not. To the analogies between live and dead things and their possible implications, Prof. A. E. Boycott devoted his recent presidential address to the Section of Pathology of the Royal Society of Medicine, a revised version of which we publish as a supplement this week. Such a comparison is useful, since, although chemistry and physics have helped greatly in the interpretation and understanding of the mechanisms of living organisms, they have not yet succeeded in explaining life.

A living organism is an entity, a discrete unit; the live world is made up of such discontinuous pieces. But though at first sight the dead world may appear continuous, it also in reality is composed of particulate matter and energy, molecules, atoms, quanta. Ultimate analysis has merely led to the discovery of smaller particles, and a fractional atom is as impossible as a fractional animal.

Again, the origin of one species from another in the course of evolution has its modern analogy in the derivation of one element from another; apart from the time factor, chemical elements are not necessarily more stable than zoological species; lead or a dog may not always have been so, and cannot be trusted to be so indefinitely in the future. It is even possible that as the disintegration of radioactive elements cannot be controlled, so also may the evolutionary sequence of animals be predetermined, although the actual course may be

deflected by changes in the environment. Both elements and species can be arranged in groups according to their general characteristics; the position in the table indicates their properties or characters and gives a clue to their past history.

The capacity of self-repair is one of the greatest characteristics of living beings; a multicellular organism repairs injury by the growth of certain cells usually specifically set aside for this purpose and endowed with the capacity of growth and proliferation, even though some of the cells actually injured die and are not replaced. Whether an injured unicellular organism, such as a bacterium, ever undergoes a similar process of repair is more doubtful; it is more probable that the repair is reflected in an increase in the numbers of the race rather than in a recovery of the individual. Atoms are continually losing electrons, as, for example, when electrical energy is manifested; but they do not change in nature so that repair, the picking up of an electron, must take place.

The variations among the organisms of a single species are obvious enough, and it is known that atoms show a similar variability, and that the atomic weight is merely the mean value for the whole species. Biological measurements made on a similar scale to physical or chemical might result in biology also becoming an 'exact' science.

A further analogy between the living and the non-living can be drawn from the examination of the courses of the reactions in the hydrolysis of cane-sugar by dilute acid and the destruction of bacteria by heat or disinfectants. Both follow a similar path; the bacterium behaves as the molecule of cane-sugar, the proportion killed or hydrolysed depending on the number of organisms still living or on the number of molecules still unchanged. The organism acts as the unit. If the molecules of the organism were the units and had been destroyed according to the same law, it would have been expected that a stage would have been reached when all the organisms would have died together, whereas, in fact, this destruction only occurs gradually.

There is difficulty, however, in finding an analogy to reproduction in animals. Reproduction appears to be necessary because organisms are unstable; without it they could not maintain themselves. But provided that conditions remain constant, the number of any given species does not change greatly from year to year; the capacity for reproduction enables organisms to adapt themselves to varying conditions rather than to increase, except perhaps slowly, in numbers. The simpler units of the inorganic world are more stable and do not need therefore to reproduce. But if speculation embraces the universe rather than the earth alone, it appears possible that the disintegration of atoms into radiation in the immense heat of the stars may be accompanied elsewhere by the regeneration of matter from energy under conditions of intense cold, giving a true reproduction of inorganic material, and the atoms formed need not be the same as those from which the protons and electrons originally came.

It thus appears that living and non-living form one continuous series, and that no sharp distinction can be drawn between them. But if so, what sort of matter forms the borderland between the two? Is it the filtrable virus, the bacteriophage and similar agents? These bodies show some of the properties both of bacteria and of non-living matter. It is probable that the average diameter of the viruses is about 25 $\mu\mu$, whilst that of the smallest known bacillus is about ten times greater, just at the limit of visibility. Organisms of this small diameter can pass through filters, and are about equal to the colloidal aggregates of dissolved hæmoglobin in size and can contain from 200 to 400 protein molecules. There appears to be a break in the series of micro-organisms between bacteria and viruses, perhaps analogous to the fact that even the smallest mammal has a very definite size. The range in size in the bacterial group is of the same order as in the mammals, and the ultramicroscopic viruses may show a similar range. The composition of the latter is unknown; it is probable that protein is present, since a virus infection frequently gives rise to a long-lasting immunity; on the other hand, provided a minimum dose is given, the severity of the infection is little altered by giving doses even many thousands of times greater; viruses apparently do not produce poisonous substances as do so many bacteria.

Many viruses are extremely resistant to destructive agents; others are much more delicate. But, unlike bacteria, no virus has been successfully grown in artificial culture without the presence of other cells; in fact, they seem to multiply only in the presence of living cells and preferably young growing cells. It is quite possible that they are obligatory intracellular parasites and that this habit of life may explain some of their peculiarities.

Though, however, the viruses are related to the bacteria in some of their characteristics, they also show phenomena analogous to those produced by material which is usually considered to be non-living. Thus the products of autolysis of dead

cells stimulate growth as well as an agent obtainable from malignant tumour cells. The presence of the latter is indicated when malignant epithelial cells stimulate normal connective tissue cells to grow into a transplantable tumour, a carcinoma stimulating the development of a sarcoma. This agent is presumably usually very labile, but in the case of the Rous fowl sarcoma can be obtained in the filtrate from the growth and initiate a tumour on injection into another bird; no living agent can be seen or cultivated in such a filtrate.

The products of autolysis are 'dead' or non-living: Is the Rous agent living, or simply a non-living material which can stimulate certain cells to pathological overgrowth? It multiplies only where its specific activity is displayed, and it may survive drastic methods of purification. There is good evidence that tumours produced by chronic irritation contain a carcinogenic 'virus'; that is, the irritation stimulates the cells to overgrowth, with the result that they produce the virus. Hence the latter arises *de novo* in each tumour in the growing cells, and the means of propagation of the disease are not the same as those by which it was originally started.

Applying such reasoning to the true virus diseases, for example, foot-and-mouth disease, the question arises whether the disease may not itself produce the virus; in other words, although the infection is spread by a minute dose of virus, multiplication only occurs in the presence of the specific lesion, so that the virus obtained from the lesion need not be the direct descendant of the infecting virus, in the same way as bacteria only arise from pre-existing organisms. In spite of difficulties, epidemiological, immunological, and other, against this view, there are items of evidence in its favour, such as the production of a transmissible inflammatory disease of the rabbit's testis, by inoculating a filtrate of testis emulsion from one rabbit into another's testis; although compounds from an animal's own tissues do not usually behave as antigens in the same animal, there are exceptions to this rule. Lysozyme, again, has many of the properties of an enzyme, but it is increased in amount when it acts upon its specific micrococcus.

It is therefore possible that viruses are pieces of living cells, which apart from their proper environment have abnormal actions, in this case harmful, since those with the harmful actions are the more easily apprehended. They would therefore form part of a continuous series stretching from obviously non-living matter through the growth-promoting substances, the viruses, and the bacteria to the higher plants and animals. But even if such substances can be considered as both living and arising *de novo* under the appropriate stimulus, the problem of their evolution into a higher microbe is still unsolved, and the conditions for this evolution may not obtain on the earth at the present time; whilst if they are held to be non-living, there appears to be no trustworthy evidence that life can arise except from living matter. Science still has far to travel before even the humblest bacillus can be produced at will.

Wild Nature and Gentle Savages.

Wanderings in Wild Australia. By Sir Baldwin Spencer. Vol. 1. Pp. xxviii + 455 + 210 plates. Vol. 2. Pp. xiv + 457-930 + 194 plates. (London: Macmillan and Co., Ltd., 1928.) 42*s.* net.

NO one has done more valuable work in elucidating the ethnography of the aborigines of Australia than Sir Baldwin Spencer, and therefore a new book by him deserves careful consideration. "Wanderings in Wild Australia" is possibly the final record of travels and field-work begun thirty-four years ago and continued at intervals until within a few years. The area of the wanderings is, roughly, between 132° and 136° E. long., and from Lake Eyre in the south to Bathurst Island and the Gulf of Carpentaria in the north.

The first two parts of the present work closely follow the information given in "Across Australia," by Spencer and Gillen (1912), together with ethnographical additions which are to be found in "The Native Tribes of Central Australia," by Spencer and Gillen (1899), and the new and improved edition of "The Arunta" (1927), which has already been noticed in NATURE (Mar. 17, 1928, p. 411), as well as observations from "The Northern Tribes of Central Australia," by Spencer and Gillen (1904). The third part deals with the Kakadu of the East Alligator River (Arnhem Land), Port Darwin, and Melville and Bathurst Islands, the ethnographical matter being abstracted from "The Northern Tribes of the Northern Territory of Australia," by Baldwin Spencer (1914). It will thus be seen that the fortunate possessor of the earlier books will have little occasion to consult the new book so far as anthropological information is concerned, but attention must be directed to the fact that there are a few new photographs which illustrate parts of ceremonies, and several new representations of the very interesting carved and painted grave posts of Melville and Bathurst Islands. Those interested in gesture language (vol. 1, pp. 436-444) will find

nineteen additional signs in "The Arunta," vol. 2, Appendix F. There are several new sketches, mainly of scenery, by the author, and three or four new maps and two instructive block diagrams showing the relation of the geology of the scenery of the Macdonnell Range.

The foregoing is written from the point of view of an ethnologist, but there is another aspect from which the book may be judged. The author gives records of various journeys which bring before the reader a vivid picture of the geographical and biological conditions from south to north of the central belt of Australia, and as he was the professor of biology in the University of Melbourne, we have the satisfaction of finding the plants and animals correctly identified. The great differences in the flora and fauna and in the country itself during a dry spell from those immediately following a fall of rain account for the diverse opinions expressed by travellers in the past. We are told how certain plants and animals adapt themselves to these very contrasted conditions—of succulent and spiny plants, of the æstivation of animals, and of the frogs which are dug up by the natives in the dry season in order that the latter may drink the water with which the frogs have distended themselves.

So from stage to stage we are pleasantly conveyed, and learn how travellers and settlers fare in those remote and often most inhospitable regions, and the information is appropriately illustrated by numerous beautiful photographs of scenery and vegetation, with a few representations of animals. In this way the stage is set for the human performers in the drama of Australian physical and biological conditions.

Most travellers have come across only small bands of wandering natives, with few and crude belongings, who were wresting a precarious living from niggard Nature, and not unnaturally a common opinion has arisen that the people are a miserable, poor, and cultureless folk. But, thanks to the researches of Sir Baldwin, we now know that on stated occasions the natives assemble from far and wide to spots where water and food are temporarily abundant, and then the dull, isolated, secular life is exchanged for a period of happy social intercourse and the performance of numerous spectacular religious performances. It is impossible to give even a summary of the wealth of information here given concerning these most interesting ceremonies, which, by the way, are fully illustrated by excellent photographs. The reader of the book will get, as he cannot obtain anywhere else, a picturesque but scientific account of the daily life, social organisation, ceremonial life, magic, religion, death, burial, and mourning of various tribes; nor are the objects they make and the method of their manufacture neglected.

Towards the end of 1911, the Minister for External Affairs of the Commonwealth Government wisely appointed Sir Baldwin Spencer as Special Commissioner for Aboriginals of the newly established Northern Territory, and in the chapter entitled "Work in Darwin" we have a hitherto unpublished account of the first two months of his actions as Chief Protector in charge of the department instituted to safeguard the interests of the aboriginal population. This very interesting chapter shows how necessary such an appointment was, since the natives were being hopelessly demoralised by Chinese and Malays. The Commonwealth Government has shown in this way, and in appointing a Government anthropologist for the Mandated Territory of New Guinea, that it appreciates the practical value of ethnology, as indeed the Government of Papua has done for many years.

A. C. HADDON.

Marine Engine Practice.

Marine Engineering in Theory and Practice: a Complete Text-Book on Heat Engines and Mechanical Engineering connected with them, including Steam Engines and Boilers, Turbines and Internal Combustion Engines and Auxiliary Machinery, both in their General Application and in particular Reference to Types used and to Practice at Sea; for Marine and other Engineers, and Naval Architects, Officers, Apprentices, and Students. By Eng. Comdr. S. G. Wheeler. Vol. 1: *Elementary.* Re-issue with Appendix. Pp. xi + 182 + 8. Vol. 2: *Applied.* With a Special Chapter on Metals and Strength of Materials, by Comdr. G. C. Malden. Pp. xi + 183-597. (London: Crosby Lockwood and Son, 1928.) Vol. 1, 10*s*. 6*d*. net. Vol. 2, 35*s*. net.

THE principal part of Vol. 1 of Wheeler's work is devoted to an explanation of the elementary theory of heat engines and of the fundamental principles of their action. There is nothing new in the subject matter, but the treatment differs from that ordinarily adopted. It is intended for the primary education of engineers engaged in the naval and merchant services, and the style has been modelled to suit. Throughout, the aim is to impart a sound grasp of the rudimentary principles, rather than to describe exact methods of calculation. Elaborate mathematics are carefully avoided

and diagrams used freely. The reader is always encouraged to visualise what actually occurs during any operation that is being explained, and tentative theories and analogies are resorted to in order to facilitate explanation.

To the trained engineer, some of the attempts in this direction appear at first to be somewhat crude, but their effectiveness has no doubt been proved in a wide experience in teaching this subject. The diagrams employed are those which give the simplest and most direct representation of the function or performance concerned. The pressure–volume chart is used wherever possible, and the temperature–entropy chart, which the more advanced student would in many instances find more convenient, is studiously avoided. However, the employment of the pressure–volume chart in connexion with unrestricted expansion of steam, while useful as a connecting link between the cases of restricted and unrestricted expansion, is not the most satisfactory for representing the energy transformation of the latter. Diagrams showing the losses which occur in the various transitional stages between the burning of the fuel and the development of power on the propeller shaft are particularly useful.

Generally speaking, the attempt to present the case in a simple and easily understandable manner is commendably successful, but a few suggestions might be made for a future edition. The means adopted for the purpose of getting the reader to appreciate physical facts and functions rather than abstract formulæ, lead to some redundancy, and while this, as a consequence, is probably inevitable, its effect could be largely counteracted by effective summarisation. The statement is made that it is impossible to obtain a steam velocity greater than the velocity of sound with a nozzle which has no divergence at outlet. This is quite a common mis-statement of fact in books of this kind, and yet in actual pressure-compounded impulse turbines such nozzles are quite commonly employed for pressure drops greater than the critical.

In some cases where values are given by way of example, it should be made clear that they are not absolute and are liable to considerable variation in practice. For example, it is stated that the 'design factor' or ratio of work actually obtainable to that which the pressure–volume diagrams show to be theoretically available should be taken as 0·49 for triple expansion reciprocating engines. This factor, of course, varies over a wide range for different engines and conditions. Again, it is stated that for the steam consumption rate of marine turbines a value of 14 lb. per shaft horsepower per hour may be taken, whereas there are actually on service at the present time marine turbine installations operating with a steam consumption rate of approximately half that value.

However, the general treatment of the subject is good, and the book should be much appreciated by young engineering students and those responsible for their education.

The major portion of Vol. 2 is devoted to describing systems of marine propulsion and types of engines, boilers, and accessories. The description is of a very practical nature, is very well done, and accompanied by a large number of excellent illustrations. The first chapter deals with turbines, and commences with a very logical classification of all types, land turbines being wisely included for the sake of completeness. The principle of operation and the practical features of the various types are then separately described, and a large number of actual examples illustrated. This is followed by a similar description of the most important constructive details. The special requirements for ship propulsion are then discussed, and the chapter concludes with a useful review of recent tendencies in practice and design. The means which have been adopted for reducing the loss due to the velocity of the steam leaving the final stage are very fully examined, although this is primarily a land turbine problem.

Internal combustion engines are dealt with in a similar manner in the next chapter, which commences with a proper classification and then proceeds with the description of the principle of operation, and the constructional features of each type. The special apparatus required to meet marine requirements, such as reversing gear, are then dealt with, and 'heat engines reversed,' or refrigerators, are included in this section. There is no corresponding chapter on reciprocating steam engines, the treatment of which in the first volume is presumably deemed sufficient. The chapter on ship propulsion gives a brief account of the laws of resistance of ships and the action of the screw propeller, and then describes a large number of arrangements of propelling machinery of various types. The methods which have been adopted for gearing the engine shaft to the propeller shaft, namely, mechanical, electrical, and hydraulic, receive appropriate attention, and torsion meters are also included.

In the chapters on boilers, every type which has been used at all extensively in either land or marine practice is suitably illustrated and described, with

the most important boiler-room auxiliaries. The chapter on feed-water, etc., opens appropriately with a full discussion on the necessity of and methods for preserving boiler feed-water from impurities, after which, condensers and their auxiliaries are dealt with. This concludes the purely descriptive portion, and its comprehensiveness may be gathered from the above résumé and from the fact that this portion of the book contains more than 300 illustrations.

The treatment of the subject of combustion is very thorough, both from the theoretical and practical point of view, and the chapter on metals, etc., takes an excellent survey of the factors which influence the physical properties of the metals ordinarily employed in engineering structures. The last chapter describes various steam charts and their uses, and the book concludes with a supplementary set of examples, exercises, and explanatory notes.

Taking into consideration the time which the collection of so much matter must have occupied, and the recent rapid progress in marine engineering, the book is remarkably well up-to-date. A few of the examples illustrated are obsolete types, but have been wisely included in order to show on what lines progress has been made. In a future edition, reference could with advantage be made to the recent development of high pressure and temperature geared turbine installations, to the combination of reciprocating engines with exhaust steam turbines geared to the same propeller shaft, to the development of the double acting internal combustion engine for large powers, and to the experimental work which has been done in connexion with internal combustion turbines.

This volume should prove useful both for textbook and for reference purposes.

Evolution.

(1) *Charles Darwin: the Man and his Warfare.* By Henshaw Ward. Pp. viii + 472 + 27 plates. (London: John Murray, n.d.) 21*s*. net.

(2) *The Evolution of Charles Darwin.* By George A. Dorsey. Pp. xii + 300. (London: George Allen and Unwin, Ltd., 1928.) 7*s*. 6*d*. net.

(3) *Darwinism and What it Implies.* By Prof. Sir Arthur Keith. (The Forum Series, No. 8.) Pp. vii + 56. (London: Watts and Co., 1928.) 1*s*. net.

THE large number of publications which have made their appearance during the last few months upon the subject of evolution affords interesting evidence of a growing appreciation on the part of the general public of the importance of some acquaintance with the general conclusions of biological science as part of the mental equipment of the ordinary citizen.

(1) Mr. Henshaw Ward's "Charles Darwin: the Man and his Warfare" is a book of quite unusual merit. The professional biologist will while away a few hours in its perusal with much pleasure, while the layman interested in Darwinism will gain from it a vivid picture alike of the personality of the master and of the various steps in the long campaign which culminated in the conversion of the intellectual world to belief in evolution. The author, while apparently not a specialist in biology, shows a wide acquaintance not merely with the works of Darwin himself but also with the writings of others about him and his philosophy, and about his chief contemporaries in the world of science, and this has enabled him to form in his mind a peculiarly vivid picture of Darwin's personality and surroundings—a picture he puts before us with much literary skill in the book under review.

The book is really a scientific biography written for the general reader. In its fourteen chapters the life of Darwin is divided up into contrasted sections. "A Year with Fitz-Roy and Lyell," "Six Years of Coral Islands and Species," "Eight Years of Barnacles," "Writing the 'Origin,'" "The Reception of the 'Origin,'" "Darwin's Life after 1850," are chapter headings which will give an idea of the general plan of the book. What they give no idea of is the lively and graphic style in which it is written, or the remarkable vividness of the picture of Darwin and his life which they call into being in the mind of the reader. The book is not merely a picture of Darwin himself and his doings: it also brings in excellent portraits of those of his contemporaries who played important parts in relation to it. Hooker was "a brawny tar, with a handshake like a taut sheet, and a laugh like a favoring gale." "An odd figure he was. The head was prone to be cocked at a sort of owlish angle for careful inspection of whatever came into view." "Such a handling of men in a complicated situation [during his travels in Sikkim] is good training for the battle at Oxford in 1860." Lyell, Huxley, Owen, Wallace, are all faithfully portrayed. "There was in Wallace's nature a beauty that will shine when the splendour of Agassiz and the greatness of Lyell are dim. He never laid claims to more honour than the Linnean paper gave him, and so gained a higher kind of fame than scientific discovery can bring."

As may have been gathered, the language in which the book is written is the American variety of English, but any little peculiarities that jar on the purist in literary style may well be pardoned for the sake of the end result : an extraordinarily readable and useful book. It is, by the way, provided with numerous and excellent illustrations.

(2) Dr. George A. Dorsey is well known as the author of "Why we behave as Human Beings," a book which in the United States enjoys deservedly a big circulation, giving as it does an excellent sketch of those results of modern physiology which are of greatest importance to the ordinary citizen. Dr. Dorsey has now published a book entitled "The Evolution of Charles Darwin." "To understand Darwin is to understand human beings," he says in his preface, and the whole book is a study of Darwin as a human being. It is well done, and in parts is charming, such as the chapter on Darwin as the father of his family, where the author recalls the little daughter running downstairs with the stolen pinch of snuff for her father, and the four-year-old son approaching him with a bribe of sixpence to induce him to come and play during working hours. The book is interesting and well worth reading, though many a biologist will demur to the statement that Darwin became a man of science "in spite of his germ plasm," and many a Trinity man to that which attributes to Christ's the honour of having nurtured Isaac Newton.

(3) Sir Arthur Keith's "Darwinism and What it Implies" is a sequel to his earlier volume in the Forum Series, "Concerning Man's Origin," and deals with some of the bearings of Darwinism upon problems of everyday life. The nature of mind, foundations of human nature, problems of sex, the spirit of competition, are headings that catch the eye. "Every fact known to them [medical men] compels the inference that mind, spirit, soul, are the manifestations of a living brain, just as flame is the manifest spirit of a burning candle." In this connexion the old-fashioned philosopher may well ponder over the fact that by drugging the brain we can "alter the mentality" of any man or woman. The chapter has in it much that is wise, and scattered through its pages are shrewd sayings. "The day man becomes a perfectly rational being marks his end." "To extinguish the spirit of competition is to seek for racial suicide": that spirit "has lifted us from savagedom, and our hopes of the future are bound in it."

The short middle chapter of the three concerns itself with "The Nature of Man's Brain," while the third, "Modern Critics of Evolution," is a reply to articles in the *Nineteenth Century* by Mr. George H. Bonner and Prof. J. A. Fleming. It may perhaps be doubted whether such articles merit even the small expenditure of Sir Arthur Keith's time involved in replying to them. Anyone desiring trustworthy information as to what is known of the evolution of the animal kingdom will surely turn to those whose life's work is the investigation of the subject. It may be of psychological interest to learn what some distinguished biologist thinks about one of the great generalisations of physical science, or conversely, what a distinguished worker in one of these sciences thinks about the evolution of plants or animals, but it is of no particular moment otherwise. While it is no doubt true even to-day that there are many men of letters entirely unacquainted with the facts which demonstrate the evolution of man, surely there are few so oblivious of their limitations as to assert dogmatically with Mr. Bonner: "There is not a shred of conclusive evidence for the animal ancestry of man."

Our Bookshelf.

(1) *Heat, Light and Sound: for School Certificate Students.* By E. Nightingale. (Bell's Natural Science Series.) Pp. xiii + 381 + ix + 11 plates. (London: G. Bell and Sons, Ltd., 1928.) 6*s.* 6*d.*
(2) *Sound: for School Certificate Students.* By E. Nightingale. (Bell's Natural Science Series.) Pp. ix + 273-381 + ii. (London: G. Bell and Sons, Ltd., 1928.) 2*s.* 6*d.*

(1) The author of this little text-book is to be congratulated. His aim has been "to cover the school certificate and matriculation syllabuses in Heat, Light, and Sound in a manner which will appeal to the student." In this aim he certainly appears to be very successful. The subject matter contains the latest available information, obtained from the most trustworthy sources. The whole is presented in an instructive and attractive manner. The illustrations alone are worthy of special mention, in many cases being self-explanatory and thus relieving the text of an unnecessary burden. The author has not forgotten the historical side of the subject, and short biographies and experiments of famous physicists have been introduced in appropriate places.

Experiments which 'work' are well described, and there is little excuse for failure to repeat them. An excellent feature of the book which must be noticed is the delightful selection of homely and *effective* illustrations and examples. Some of these are reminiscent of Bragg's "World of Sound," and the author has been wise in following the example of such an eminent leader.

Mr. Nightingale's effort is an example of what a text-book for young students should be. The information it contains is accurate and up-to-date

and is presented in the style of an experienced teacher. It can be recommended unreservedly to teachers and students as an excellent text-book.

(2) This little book is one of a set of three written for matriculation and school certificate students. It forms Part III of the combined text-book mentioned above.

The Protamines and Histones. By the late Prof. Albrecht Kossel. Translated from the original German Manuscript by Dr. William Veale Thorpe. (Monographs on Bio-chemistry.) Pp. xi + 107. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1928.) 9*s.* net.

IT is indeed fortunate that Prof. Albrecht Kossel was able to complete the manuscript of this little volume before his death, since more than any other single investigator he had contributed greatly to our knowledge of these two groups of protein compounds. The protamines, the simplest known proteins, are characterised by yielding on hydrolysis only about four different amino-acids, whereas about twenty units may be obtained from a typical complex protein. Moreover, the amino-acids found are chiefly those of basic character, arginine, lysine, and histidine. The protamines are found solely in the sperm and testicles of certain fish. The histones are more complex, containing a greater variety of units; they are, however, like the protamines, of a basic nature. They are found in the ripe sperm of certain vertebrates and invertebrates, including some fish, as well as in the nucleus of the red blood cell of the bird and in the thymus gland of the mammal. Both protamines and histones occur in Nature in combination with nucleic acids.

The monograph describes in detail the methods available for the preparation of these compounds and the separation of the various units after their hydrolysis. Separate chapters are devoted to a description of the various individuals of these two groups which have so far been isolated as chemical individuals. The importance of the study of such proteins lies in the light which it may shed on the composition and origin of the more complex of these nitrogenous compounds. Although primarily a work for the specialist, the volume has an interest also for those who wish to know something of a group of compounds which are not usually considered in much detail in text-books of bio-chemistry. The bibliography extends to upwards of two hundred references.

Leached Outcrops as Guides to Copper Ore. By Augustus Locke. Pp. vii + 175 + 24 plates. (London: Baillière, Tindall and Cox, 1926.) 22*s.* 6*d.* net.

THE object of this book is stated by the author to be the task of "reconstruction of the sulphide formerly existing." In the majority of cases a deposit consisting of iron pyrites closely intermixed with chalcopyrite or other copper ores, and possibly also other sulphides, does not often come up to the surface in this form, but is usually overlain by a capping, sometimes of very great thickness, of the oxidised products of this ore, and the problem which the author desires to investigate is that of predicting from the nature of the capping the character and richness of the primary ore. He has turned his attention mainly to disseminated deposits and has practically neglected the massive ones, which are by far the more important on the continent of Europe. The result is that the book is, to use the author's words, "overwhelmingly American"; obviously the complete study of the subject would have included an investigation of the cappings of such deposits as the cupriferous pyrites of Huelva and those of Sulitelma and other Norwegian occurrences, about which there is in fact a great deal known.

The author has gone into very much minute detail, more especially as to the character and appearance of the limonite which generally results from the oxidation of iron pyrites, but it cannot be said that his results are of any very general use. As he himself says: "The kind of capping that means ore in one district, does not necessarily mean ore in another." Obviously, if this statement is true, and there is little reason to doubt it, of two districts in the western United States, it applies with even greater force to more remote regions or to other continents. The author appears here and there to realise that his theoretical methods are of little real value, and most mining engineers will concur in his dictum.

Farm Soils: their Management and Fertilization. By Prof. Edmund L. Worthen. (The Wiley Farm Series, edited by A. K. Getman and C. E. Ladd.) Pp. x + 410. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1927.) 13*s.* 6*d.* net.

UNDER modern systems of farming, it is recognised that soil management must be considered in relation to the specific crops to be grown, and the present volume attempts to correlate the various farm operations with economic crop production. The management of any soil will necessarily vary with the type of crop, as treatment that is merely adequate for fruit or garden produce might be hopelessly extravagant and uneconomic for large scale field crops.

Prof. Worthen keeps the practical aspect in view throughout, and by means of 'community studies' the student is led to investigate problems in the field for himself and to consider the best means for their solution. The main farming operations are dealt with in detail from various aspects, chapters being devoted to water supply, tillering, manuring, liming and green manuring. The correlation between soil management and the crop grown is brought out by short accounts of the appropriate treatments for field, pasture, garden, and fruit soils, and emphasis is laid on the importance of the cultivator becoming as familiar as possible with the local practices of his district. Special care has been taken with the illustrations, which are selected to bear directly upon particular points in the text, and numerous references, solely of American origin, are also included.

Lehrbuch der Protozoenkunde: eine Darstellung der Naturgeschichte der Protozoen, mit besonderer Berücksichtigung der parasitischen und pathogenen Formen. Begründet von Franz Doflein. Neubearbeitet von Prof. Dr. Eduard Reichenow. Fünfte Auflage. Teil 1: *Allgemeine Naturgeschichte der Protozoen.* Pp. iv + 436. Teil 2: *Spezielle Naturgeschichte der Protozoen.* Hälfte 1: *Mastigophoren und Rhizopoden.* Pp. iv + 439-864. (Jena: Gustav Fischer, 1927–1928.) Teil 1, 21 gold marks; Teil 2, 22 gold marks.

Doflein's text-book of Protista has been for many years the classical volume for students of protozoa. Owing to the number of recent contributions to the literature of this subject, the last edition published in 1916 rapidly became out-of-date. The new volume, of which the first two parts have appeared rearranged and edited by Prof. Eduard Reichenow, is therefore a welcome production. In the main it follows the lines laid down in the fourth edition, but new sections have been introduced, such as a brief account of the comparatively new subject of soil protozoology. The first part ends with an account of the physiology of protozoa, and it is unfortunate that, in common with so many other modern text-books, this aspect of the subject receives rather scanty attention. In Part 2 the various groups of protozoa are considered, taking the reader to the beginning of the Sporozoa group. The present volumes maintain the high standard set by the late Prof. Doflein, and will be an indispensable part of any zoology library.

Air Ministry: Meteorological Office. The Observatories' Year Book, 1926: comprising the Meteorological and Geophysical Results obtained from Autographic Records and Eye Observations at the Observatories at Lerwick, Aberdeen, Eskdalemuir, Cahirciveen (Valencia Observatory), and Richmond (Kew Observatory), and the Results of Soundings of the Upper Atmosphere by means of Registering Balloons. (M.O. 304.) Published by the Authority of the Meteorological Committee. Pp. 411. (London: H.M. Stationery Office, 1928.) 63*s.* net.

The Observatories' Year Book for 1926 has followed that for 1925 at an interval of 9½ months, indicating progress towards the desirable goal of the issue of each year's observations during the following year. The volume is enlarged by about forty pages by the inclusion, for the first time, of hourly magnetic data from Lerwick, the most northerly British observatory (60° 8′ N.). In going from the Abinger magnetic observatory (the results for which are published in the Greenwich volumes) to Eskdalemuir, 4° to the north, there is a transition towards more disturbed conditions, but the increase of disturbance in going 5° farther north still, to Lerwick, is much greater. The immense mass of meteorological and geophysical data recorded in these volumes with such convenient uniformity provides material not only for present researches, but will also almost certainly prove of use in ways yet unthought of to future generations.

Orcharding. By V. R. Gardner, F. C. Bradford and H. D. Hooker. (McGraw-Hill Publications in the Agricultural and Botanical Sciences.) Pp. xi + 311. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1927.) 15*s.* net.

This volume marks a definite attempt to fill the gap which exists between the practical considerations which govern the growing of fruit trees and the fundamental principles upon which such practice is founded. Scientific explanations are suggested for many of the problems which beset the grower, as, for example, the biennial fruiting habit of the majority of apples. Under questions of growth and nutrition, that of the carbohydrate supply of the tree is specially dealt with, as being of much importance in relation to the production and quality of the fruit.

Quality is becoming of increasing importance with increasing competition, and in consequence greater attention is necessary to keep fruit trees free from insect and fungus pests, chiefly by means of various types of spray. Appropriate marketing includes grading, attractive packing, careful transport with refrigeration if necessary, and the best choice of locality and salesmen, and due attention to all these details is essential for success and profit in fruit-growing on a commercial scale.

A B C of Adler's Psychology. By Philippe Mairet. Pp. 116. (London: Kegan Paul and Co., Ltd., 1928.) 3*s.* 6*d.* net.

An excellent book. Adler's individual psychology makes an appeal to those people who do not like to accept the more extreme views of Freud, Jung, or Stekel, but still feel the need of a practical psychology to explain many of the mal-adaptations and neurotic features of the individual. In this short summary, Mairet has made a very satisfactory presentation. The author briefly traces the development of modern psychological ideas, and shows how Adler was led from his wide experience as a physician to build up his theory of inferiority and the individuals striving for superiority. Throughout the book there is a sound emphasis on the importance of individual psychology to the social, religious, and educational aspects of the community.

Man: What? Whence? Whither? or, The Faith that is in Me. By Capt. R. C. T. Evans. Fourth edition. Pp. viii + 218 + 11. (Chatham: Parrett and Neves, Ltd., 1928.) 2*s.* 6*d.*

Those who like a book to deal with a wide range of topics will be well satisfied with Capt. Evans's encyclopædic little volume. It deals with free-will, conscience, suffering, reincarnation, prayer and miracle, the flood, psychical phenomena, sacraments, the Trinity, and so on. The sincerity and earnestness of the writer are transparent, and as arousing reflection his work should prove valuable to many readers. It is intended primarily for those who are troubled by the apparent antagonism between religion and science, "in the hope that what comforted me may comfort them." The book is fertile in argument and contains much ingenious speculation. J. C. H.

Letters to the Editor

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Constitution of Nitrated Cellulose.

IN a recent publication (*Zeit. für physikal. Chem.*, **130,** 616; 1927), Herzog and von Náray-Szabó gave an account of the X-ray examination of ramie fibre nitrated in various ways, and concluded that for any nitrocellulose containing from 4·41 to 13·31 per cent of nitrogen the diffraction spots on the 'fibre diagrams' were produced mainly by the substance cellulose trinitrate, two spots from unchanged cellulose occasionally persisting, and that all nitrocelluloses were therefore principally mixtures of cellulose trinitrate and cellulose.

Two rather diffuse diagrams were given, one of which (for 12·99 per cent nitrogen) seems to show evidence of imperfect nitration. In the later paper by von Náray-Szabó and von Susich (*Zeit. fur physikal. Chem.*, **134,** 264; 1928), this diagram, with the unit cell proposed for cellulose, is withdrawn and replaced by a new diagram in which the layer lines are closer together, but the claim is still made that the nitrocellulose diagram is always compounded of those of cellulose and its trinitrate. This theory is open to serious objections from many aspects of the chemistry and technology of nitrocellulose. Many of these have been presented by Brunswig in two interesting articles (*Zeit. fur ges. Schiess- und Sprengstoffwesen*, **23,** 337 and 384; 1928).

In an investigation which has been carried on in these laboratories for more than a year, a complete range of samples of nitroramie nitrated in widely different mixed acids, together with their denitration products, has been examined by X-ray diffraction methods. The fibre diagrams of the nitrates are frequently lacking in definition and are difficult to interpret, but whenever measurements have been possible they have been found to afford only the slightest basis for Herzog's theory.

The nitration of cellulose in mixed acid is complicated by a loss of fibre structure which occurs with all mixed acids, for example, with those containing from about 30 per cent to 60 per cent of nitric acid, whenever the nitrogen content of the nitrocellulose reaches about 7·5 per cent. It continues until 10·5 per cent of nitrogen is exceeded. If the content of sulphuric acid is increased and the ratio H_2SO_4/H_2O has a certain value (about 1·7 to 1), the disintegration of the fibre structure may be greatly accentuated. It is therefore convenient to consider three groups.

The diagram of a nitroramie of less than 7·5 per cent of nitrogen shows the same spacings as that of its denitrated product but different relative intensities and is much weaker. The spacings remain constant with increasing degree of nitration. This type of diagram (B) may be contrasted with that of unaltered cellulose (A). It resembles that of fully mercerised cellulose, but excels it in sharpness and the intensities of the two are different. The diffractions characteristic of the trinitrate do not appear, although from a mixture of unnitrated ramie with comparatively little of the highly nitrated fibre it is quite easy to produce them.

In the second group (7·5 to 10·5 per cent) the nitrated material loses its fibre structure more or less, diffuse diffraction rings appear, but the denitrated product is still of type B and gives sharp lines.

As to the third and technically important class, sharper diagrams of which have been produced by von Náray-Szabó (loc. cit.) and by Andress (*Berichte*, **61,** 603; 1928), nitration in acids of technical composition nearly always results in diffuse spots, and the most important factor in securing definition seems to be a high content of nitric acid, say 50 per cent of the nitration mixture. In the cases of both cotton and ramie, as the nitrogen content falls to about 11 per cent, certain spots from planes parallel to the fibre axis are altered in spacing through small ranges in which confusion with diffractions of remanent cellulose of either type is not possible. In some instances the diagrams show an equatorial spot which falls in the same position as the $A4$ spot of cellulose, but its intensity is quite disproportionate to the possible cellulose content and its position changes on denitration. The denitration product from highly nitrated ramie is practically indistinguishable from that of pure cellulose (type A), but as the nitrogen content decreases to about 12 per cent, type A passes into type B more or less gradually, according to other conditions holding in the nitration.

It appears, therefore, that by the action of the mixed acid the cellulose residue is converted into type B for all but the highest degrees of nitration, and that the lines obtained in the range 10-12 per cent of nitrogen do not coincide with those given by the trinitrate or by cellulose of either type. Even if spots of type B were present it would not be certain, in view of the diffractions given by the less nitrated products, that they originated from unnitrated cellulose.

To account for these facts in a systematic way further data will be required, and it will probably be of great use to determine accurately the densities of certain nitrocelluloses and their denitration products and so obtain some indication of the closeness with which their structures are packed.

F. D. MILES.
J. CRAIK.

Nobel Research Laboratories,
Ardeer, Jan. 7.

The Distribution in Space of the Sunlit Aurora Rays.

SOME time ago (NATURE, Sept. 3, 1927) I discussed the position of the sunlit aurora rays with my colleague, Prof. Krogness, and he made the suggestion that the great heights of these rays might perhaps be explained by assuming that the sun's radiation pressure pushes away the upper atmosphere like a small tail of a comet, and if the corpuscular rays hit this tail they produce aurora at unusual heights.

As this idea seemed very promising, I again took up the calculations of the aurora rays in the period from 1911 to 1922, mentioned in my letter to NATURE of Sept. 3, 1927. The only two occasions when sunlit aurora rays were photographed simultaneously from two stations in order to obtain their altitude were during the nights of Mar. 22–23, 1920, and May 13–14, 1921.

In Fig. 1 we see the position of all the rays from these two nights compared with the position of the earth's shadow. The figure represents a vertical section of the earth, and the tangent to the earth's surface is the boundary between the sunlit and dark atmosphere. For each point of an aurora ray the position in the vertical plane through the centre of the earth and the sun is marked by a small circle for aurora of Mar. 22–23, and by a black dot for aurora of May 13–14. On each aurora ray two points are calculated and combined with a straight line representing the ray. This line is continued beyond the points as far as the photographs indicate. If the ray passes out of the photographic field it is marked by an arrow, and if the foot or summit can be seen on the photograph no arrow is given. Some rays form a

rather large angle with the vertical, but this is only due to observation errors on account of a small parallax.

The figure gives a very suggestive idea of the action of the sunlight; the following conclusions seem to be well founded:

1. The action is not a direct one, because the rays situated nearer the sunset point O are lower than those farther away.
2. The action of the sunlight seems to be a pressure on the upper atmosphere, driving it away tangentially to the earth, like a tail.
3. When the corpuscular rays hit this tail they produce aurora rays the height of which increases with their distance from the sunset point.
4. The sunlit aurora rays situated in this tail seem to be confined to it, and do not descend beyond the frontier line between sunlit and dark atmosphere. In the space between the tail and the earth up to distances of 2500 km. from the sunset point, no aurora rays are seen.
5. From 2500 km. and farther, reckoning from the sunset point, the action of the tail seems to have ceased, so that aurora rays here occur with the usual night altitude from 100 to 400 km.

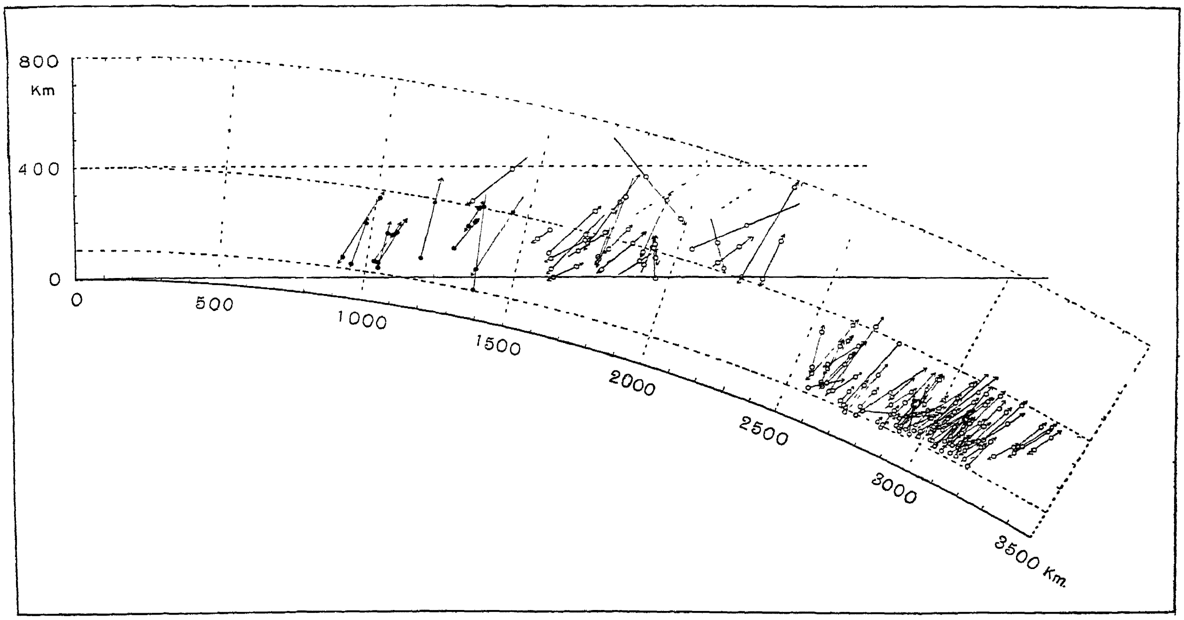

FIG. 1.

From 1922 to now a large amount of material of more than 500 photograms of auroræ from southern Norway has been collected, and amongst this are many photograms of sunlit aurora rays. It will be very interesting to see if the measurement and calculation of these rays confirms the above-mentioned conclusions or not.

A still more interesting problem for solution will be to obtain the spectrum of these sunlit aurora rays.

CARL STØRMER.

Bygdö, near Oslo, Dec. 16.

The Understanding of Relativity.

THE leading article in NATURE of Nov. 3, 1928, by H. D., on this subject, contains views so unusual as apparently to deserve some notice. I have waited some time for more competent authorities to express themselves regarding these views, but as no such expression has yet been seen by me, a few brief thoughts are offered here in lieu thereof.

H. D. refers to the difficulty of explaining the theory of relativity. The attempts to do so, he says, "represent the most conspicuous failure of modern scientific exposition." He says further: "The real difficulty that besets the beginner in the subject is, not to *understand* what he is told, but to *believe it*," and that, to escape this difficulty, "Salvation must be by faith and not by reason." It does seem regrettable, to say the least, that men of science should have to resort to the rôle of the 'hot gospeller,' which rarely, if indeed ever before, has been the method of scientific investigation.

Let me refer to just one point in the theory of relativity. On p. 16 of Einstein's "Relativity, the Special and the General Theory" (3rd ed., Methuen and Co., London, 1920), a man in a moving railway carriage is supposed to walk in the carriage in the same direction in which the carriage is moving; What would be the velocity of the man with respect to the railway embankment? This velocity, as everybody knows, would be the sum of the man's walking velocity added to the velocity of the carriage. But, according to Einstein, this result "canot be maintained." On p. 18 Einstein modifies the illustration, taking the earth for the railway carriage and a ray of light for the man, both moving in the same direction; in which case, according to classical mechanics, the resultant velocity of the light with respect to the earth would, of course, be the difference of the two velocities. But not so according to Einstein's theory. The velocity of the light is not at all affected by the velocity of the earth. In other words, either the sum or the difference of these two velocities is always equal to one of the velocities alone. This certainly appears to call for H. D.'s appeal to faith; for the slightest grain of common sense would never permit us to believe that $V+v=V$, or $V-v=V$, when each velocity has a real value.

It is true that Einstein endeavours to justify his views in this case by the results of the experiments of Michelson and Morley, which clearly show that the velocity of light upon the earth is always the same in all directions, whether parallel to the earth's orbital motion or at right angles to it. But is it not far more rational to account for this fact by supposing

the earth to have an ethereal atmosphere of its own by means of which the light is transmitted on the earth's surface and which is always carried with the earth in its orbital motion and also in its daily rotation near the earth's surface? We certainly do not know that such an atmosphere does not exist; and it certainly would account for the facts perfectly, without the violation of a single principle of mechanics.

Now the negative result of Michelson and Morley's experiments, in the supposed absence of this local atmosphere, constitutes the corner-stone of Einstein's theory of relativity (see NATURE, **111**, 240, and **117**, 6), and the effect of this paradoxical foundation upon even the highest intellects is illustrated by the following quotation from Sir Oliver Lodge: "The relative velocity of the light and the observer (travelling with speed u to meet it) must be $c+u$—common sense forbids otherwise,—but if he seeks to measure it he will get, we are told and inclined to believe, not $c+u$, but . . . simply c" (NATURE, **107**, 748). In other words, a great scientist admits that he is inclined to believe what he admits common sense clearly forbids him to believe. Must we, then, subscribe to such renunciation of our reasoning faculties and to H. D.'s appeal to blind faith before we can enter the portals of Einstein relativity?

EVAN MCLENNAN.

Corvallis, Oregon, U.S.A.,
Dec. 7.

MR. MCLENNAN's suggestion, as has often been pointed out, is inconsistent with the observed phenomena of the aberration of light.

His letter seems to imply that, if it is rejected, we must subscribe to "renunciation of our reasoning faculties and to H. D.'s appeal to blind faith before we can enter the portals of Einstein relativity." H. D., however, did not appeal to "blind faith," nor does he subscribe to "renunciation of our reasoning faculties." In order to grant full assent to a deduction from experiment, one must first understand the reasoning leading to the deduction, and secondly, have faith that reasoning on such foundations will not mislead. The failure of many people to give full assent to relativity is generally believed to be associated with the first factor; the article in question contended that it is actually associated with the second. The difficulty—at any rate in the special theory, which contains the paradoxes mainly responsible for the theory's bad reputation—is, not to understand a fairly simple argument, but to trust the understanding to lead to the truth when deep-rooted prejudice points in the opposite direction. H. D.

Dec. 29.

The Diffraction of X-rays in Liquids containing Heavy Atoms.

IT is now generally accepted [1,2,3,4] that X-ray diffraction in liquids is mainly due to the relative positions of the molecules and only in second instance to their inner structure. If the effect of the last factor is known, some information regarding the first factor may be obtained from an analysis of the observed diffraction pattern.[3] This circumstance is realised in the case of monatomic molecules, for example, argon, or mercury.[5,6] In most cases, however, as when using organic compounds, the inner structure is not known, and then no unequivocal conclusion, or nearly none, may be drawn from the diffraction pattern.

The use of an especial X-ray spectrograph [6] constructed by Prof. Coster and myself for the investigation of heavy (that is, absorbing) liquids has opened up a new line of attack. The guiding principle is to introduce very heavy atoms into the liquid and to get definite evidence concerning their mutual arrangement by their diffraction pattern. This diffraction pattern will depend almost entirely on the relative positions of the heavy atoms, as in comparison to their scattering power that of the other atoms may be neglected, the scattering power being roughly proportional to the square of the atomic number under the conditions of the experiment (scattering angles of 1° to 15° using Cu or Fe K radiation).

A first application was made on the diffraction of X-rays in a solution [7] of iodine ions in water and of carbon tetrachloride and methylene iodide in benzene. If the current view is accepted that the dissolved molecules in these cases are dispersed like the molecules in the gaseous state, then the theory [1,3] predicts a characteristic difference between the diffraction pattern of these solutions and that of ordinary liquids. This difference is chiefly found in the amount of scattering at small angles, which should be small in ordinary liquids and considerable in gases, and consequently also with our solutions. I was able to get experimental evidence of this effect when dilute solutions (about 1 molecule dissolved in 15 solvent) are used.

A curious peculiarity, however, was found with iodine ions (potassium and lithium iodides were used) when the concentration was increased (up to 1 molecule dissolved in 3 solvent). In this case I observed a reversal of the effect, the scattering at small angles diminishing again in a marked manner with increasing concentration. This phenomenon is not to be explained as due to a geometrical close-packing of the iodine ions, for a simple calculation [2] shows that this influence is much too small. The effect is, however, readily explained as due to the electrostatic repulsion of the iodine ions. Indeed, this will tend to keep them apart, as if the ions were much bigger, causing in this way an apparent close-packing. With lithium iodide this effect seems to be visible at smaller concentrations than with potassium iodide.

Another application of the same method has been made in studying organic compounds, especially those with long CH_2-chain (C_9-dibromide, C_{13}-dibromide [8] and C_{16}-mono-iodide were used). In this way evidence of their arrangement is obtained in a less ambiguous manner than usually.

Perhaps it is useful to add that with fatty acids, also studied, the results of Stewart and others [9] were confirmed and extended to C_{12}-, C_{14}-, and C_{16}-acids. A full account is to appear in *Zeitschr. f. Phys.*

My thanks are due to Prof. Coster for his helpful criticism.

J. A. PRINS.

Natuurkundig Laboratorium
der Rijks-Universiteit,
Groningen.

[1] C. V. Raman and K. R. Ramanathan, *Proc. Ind. Assoc for Cultiv. Science*, **8**, II, 127; 1923.
[2] P. Debye, *Jour. of Math. and Phys. Massachusetts*, **4**, 133; 1925; and *Phys. Zeitschrift*, **28**, 135; 1927.
[3] F. Zernike und J. A. Prins, *Zeitschr. f. Phys.*, **41**, 184; 1927.
[4] W. H. Keesom and J. de Smedt, *Proc. Amsterdam*, **25**, 118; 1922; W. H. Keesom, *Proc. Amsterdam*, **30**, 341; 1927
[5] J. A. Prins, *Physica*, **6**, 315; 1926.
[6] D. Coster et J. A. Prins, *Jour. de Phys*, **9**, 153, 1928.
[7] Solutions have been studied from another point of view by R. W. G. Wyckoff ("The Structure of Crystals," New York, 383, 1924) and W. H. Keesom (*Proc. Amsterdam*, **30**, 341; 1927)
[8] Kindly put at our disposition by Prof L. Ruzicka in Utrecht.
[9] G W Stewart and others, Several articles; *Phys. Rev.*, **31**, **32**; 1927 and 1928; J. R. Katz, *Chemiker-Ztg*, **51**, 384; 1927.

Population Problems.

THE article by A. M. C.-S. in NATURE of Dec. 29 shows convincingly how urgent are the population problems confronting the British community, and how inadequate is the knowledge at present at our disposal to solve them. These problems are by no means exclusively British, and they are much more acutely realised in many countries than here. It is therefore appropriate that, with the Editor's permission, I should remind readers of NATURE that an organisation has recently been established to deal with precisely such questions as are raised in the article, namely, the "International Union for the Scientific Investigation of Population Problems," with its constituent bodies, the national committees which are now being set up in each of the countries represented in the Union.

I cannot ask for space to describe the plans for developing research, both internationally and within the various national units, from which the founders of the Union, men eminent in many branches of science in many countries, confidently expect a great advance in the elucidation of population problems, and I must confine myself to the question of the financial provision on which the success of their efforts will depend.

Sufficient resources are already in great part assured to the International Union itself, and to certain of the national committees, notably those of the United States and Italy; but they are at present almost non-existent in the case of the British section. It will not do for Great Britain, with her vast and varied responsibility for human populations, to fall behind in this enterprise, and it is with the object of trying to enlist support for the British National Committee which has been formed under the title of the "British Population Society" in connexion with the Union that I am asking the Editor to publish this appeal.

The only way in which we can hope to raise the very moderate income required for current expenditure is by way of subscriptions both from institutions and from individuals, which we propose to fix at a minimum of £1 per annum, giving the right to attend meetings, receive publications, etc. The primary object of the Society is to focus and co-ordinate research, and we are therefore specially anxious that all institutions of scientific or sociological character, universities, and other learned bodies interested in one or other branch of the population question, should join the new Society. We are encouraged to hope that they may do so by the fact that two or three important institutions of this character have already consented to be represented on the council and to support our work by quite substantial subscriptions, but we should hope that individuals interested or qualified in any particular branch of population research may also be induced to join us. I need scarcely add that if we are to take a worthy share in assisting and promoting research, both by the Union and at home, much more will be needed, but for this we shall have to look in the future to the generosity of donors inspired by a conviction of the great importance of this work to the welfare of human population.

The original members of the council, which will be added to as time goes on, are Sir William Beveridge, Sir Charles Close, Sir Arthur Keith, Sir Humphry Rolleston, the Dean of St. Paul's, Mr. Maynard Keynes, Capt. Pitt-Rivers, Dr. R. A. Fisher, Dr. David Heron, Mr. M. Pease, and Profs. A. M. Bowley, F. A. E. Crew, A. M. Carr-Saunders, B. Malinowski, J. S. Huxley, and J. W. Gregory.

May I add that I shall be glad to answer any inquiries on the subject either of the International Union or the British Society, and that communications may be addressed either to me as chariman of the council, or the honorary secretary, Mr. Eldon Moore, c/o The Eugenics Society, 20 Grosvenor Gardens, London, S.W.1.

BERNARD MALLET.

8 Eccleston Square, S.W.1.

Magnetic Properties in Relation to Chemical Constitution.

THROUGH the kindness of Dr. Kapitza and Dr. Webster, we have had the opportunity of examining in the Cambridge Magnetic Laboratory a number of compounds to which formulæ with single-electron bonds have been assigned. These compounds are of two principal types: (1) *Pervalent salts*, including PCl_5, $SbCl_5$, $SbMe_3Cl_2$, $SbMe_3Br_2$, $SbMe_3I_2$, the α and β forms of $TeMe_2Cl_2$, $TeMe_2Br_2$ and $TeEt_2I_2$, α-$TeMe_2I_2$ and α-$TeMe_2I_4$, and a number of analogous compounds such as PCl_3, $POCl_3$, $AlCl_3$, TlI_3, BiI_3, CsI_3. (2) *Co-ordination compounds*, including the $Li^{\cdot}$, $Be^{\cdot\cdot}$, $Al^{\cdot\cdot\cdot}$, $Co^{\cdot\cdot}$, $Ni^{\cdot\cdot}$, and $Fe^{\cdot\cdot\cdot}$ derivatives of benzoylcamphor. Except in the case of substances containing a metal of the transition series, these compounds have all proved to be diamagnetic. We therefore conclude that all the electrons are magnetically paired, just as they are in compounds in which the valency-electrons are present as pairs of shared electrons or as 'lone pairs' of unshared electrons. The numerical results of these experiments will be published later.

We have also examined some cuprous and mercurous salts for which no magnetic data appear to have been given previously. We find that mercurous chloride and cuprous iodide are both diamagnetic, whereas mercuric chloride is diamagnetic and cupric chloride is strongly paramagnetic. The diamagnetism of mercurous chloride can be accounted for readily, since physico-chemical measurements with dissolved mercurous salts point to the existence of a diatomic ion derived from bivalent mercury, for example, $Hg_2(NO_3)_2 \rightleftharpoons Hg_2^{++} + 2NO_3^-$. Moreover, X-ray analysis of crystals of calomel has disclosed the existence of chain-molecules containing bivalent mercury, as shown by the formula Cl-Hg-Hg-Cl. The metallic atoms in the mercurous salts therefore contain completed shells of 18 unshared *O*-electrons, with an outer shell of 2 or 4 shared electrons, and are diamagnetic like the free metal. On the other hand, the copper atoms in a bivalent cuprous salt would contain an incomplete shell of 17 unshared *M*-electrons, with an outer shell of 2 or 4 shared electrons, and would therefore be paramagnetic like the cupric salts.

The fact that cuprous iodide is diamagnetic, shows that the cuprous salts, unlike the mercurous salts, contain only univalent ions or atoms of the metal. This result also is in agreement with X-ray analysis, which has shown that the structure of cuprous iodide is similar to that of silver iodide, $\overset{+}{Ag}\overset{-}{I}$. Conversely, however, the fact that cupric sulphide, CuS, is diamagnetic like cuprous sulphide, Cu_2S, suggests that it may really be a cuprous disulphide $\overset{+}{Cu}\ \overset{-}{S}\text{-}\overset{-}{S}\ \overset{+}{Cu}$, just as iron pyrites has been shown by X-ray analysis to be a ferrous disulphide, $\overset{++}{Fe}\ \overset{-}{S}\text{-}\overset{-}{S}$. This conclusion can be justified by comparison with the polysulphides of the formula Cu_2S_x; but it is also confirmed by X-ray analysis, which shows that the crystal structure of cupric sulphide is different from, and more complex than, that of all other binary monosulphides.

T. M. LOWRY.
F. L. GILBERT.

University Chemical Laboratory,
Cambridge.

A New Method of Recording Ciliary Movement.

THE rate of vibration of cilia is usually too great to permit of accurate observation with an ordinary microscope unless the light be interrupted at a suitable frequency and for suitable periods of time. If the frequency of vibration be approximately fourteen or more beats per second, the form of each cilium during the two phases of its beat, and the nature of the metachronal waves which pass over the epithelium, can be readily observed by means of a suitable stroboscope. If, however, the frequency of vibration is lower than ten per second, accurate observations of this type are impossible owing to the low intensity of illumination which is necessary to reduce 'flicker' to a convenient level. In such cases permanent records of individual cilia or of the metachronal waves can be made by synchronising, with a variable speed stroboscope, the shutter of an ordinary cinematograph camera; in this way 'slow motion' records of rapidly vibrating cilia can be obtained, and the frequency and velocity of beat can be determined with accuracy.

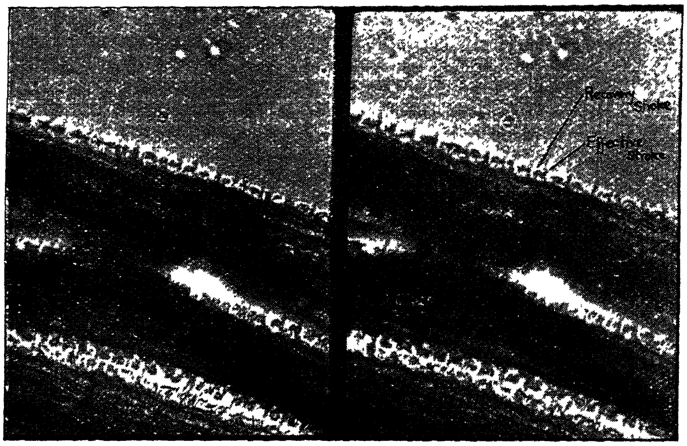

FIG. 1.—Two successive photographs of the metachronal waves passing over a ciliated epithelium. The cilia are seen in side view with their beat at right angles to the plane of the paper. Each wave has two components (i) The dark finger-like processes representing cilia in the effective phase of their beat. (ii) Semicircular waves outlined by an illuminated edge, representing cilia in the recovery phase of their beat. The waves are travelling from right to left.

The lateral cilia on the gills of *Mytilus edulis* have been examined by these methods. The frequency of vibration of individual cilia varies, in different samples of tissue, from 5 to 16 vibrations per second at 22° C., whilst the metachronal waves move over the epithelium with an average velocity of 100 μ per second. The wave-length of the wave varies with the frequency of its constituent cilia, and the form of the wave may vary from time to time at any given point without interfering with the continuity of the whole wave system.

So far as is known, this constitutes the first successful attempt to establish a permanent record of ciliary activity. With the data thus available it is possible to analyse ciliary movement with accuracy, and we are no longer restricted to observations of the velocity at which particles move over the epithelium or to the behaviour of relatively inactive cilia.

It is interesting to note that the new methods illustrate very clearly the difference in the form of a cilium during the two phases of its beat, and that the nature and propagation of a metachronal wave is closely associated with the individual properties of the constituent cilia and do not appear to be the result of an extraneous timing mechanism.

J. GRAY.

Zoological Dept., Columbia University,
New York City.

Horsetail Choking Field Drains.

FIELD drains are commonly blocked by the roots of trees growing in their vicinity. Sycamore, ash, elm, and naturally willow, are offenders in this respect; oak and beech rarely cause such trouble, at any rate in my experience. To find such mischief resulting from the rhizomes (underground stems) of the horsetail (*Equisetum*) was a revelation to me.

A wet patch developed recently in a pasture field here. The drains have just been examined and found to be stopped up in places by the matted rhizomes of *Equisetum*, presumably the common species, *E. arvense*. My man reported the matter to me, and said the stuff he had pulled out of the drain-pipes could not be tree roots, as there were no trees near, and besides the strands were soft and easily broken. He thought they might be the roots of 'sieves'—the local name for rushes (*Juncus communis*)—these weeds being now in evidence on the wet area. I greatly doubted this, and on investigation found the strands to be the underground stems of the horsetail. Hitherto I was unaware that *Equisetum* grew in this field, but my man informs me that it was quite noticeable when the ground was last ploughed towards the end of the War; and evidently it still persists to some extent.

The rhizomes have great penetrating power, for they were found in the pipes at a depth of three and a half feet. In the cuttings made down to the drainage level, the rhizomes can be seen running here and there in the subsoil, but in no great abundance. In the pipes, however, they increase greatly, giving off at each node a number of roots which branch copiously, effectually blocking the drain. The rhizome is about the thickness of a straw and the root much finer. They are both almost black in colour.

Farmers in this district are well acquainted with the plant, knowing it by the name of 'paddock pipes.' It has an evil reputation of scouring cattle.

JOHN PARKIN.

Blaithwaite,
Wigton, Cumberland,
Dec. 11.

Band Spectrum of Chlorine or Hydrogen Chloride.

IN the *Zeitschrift für Physik* for August, Kondratjew and Leipunsky describe the emission spectrum of chlorine heated in a silica tube to about 1000° C. I compared their photograph with one taken by W. West and myself in 1924 of the flame of chlorine burning in hydrogen, which shows a continuous spectrum with a maximum at 480 $\mu\mu$. I could find no record of the brand of plate used, so asked two honours students, Messrs. Reid and Soutar, to obtain a new photograph and compare it with the one obtained by simply heating chlorine. To my surprise a beautifully clear band spectrum was obtained.

The only difference in method I can recollect was that a silica jet was used for the chlorine instead of the platinum jet used in 1924. The continuous light is visible enough using a direct vision spectroscope, but is apparently of much less actinic intensity than the band spectrum in the apparatus now used. The flame is started by a spark from platinum wires connected to a small induction coil; if the sparks are maintained while the photograph is being taken, the continuous emission spectrum at 260 $\mu\mu$ is obtained as

well (Fig. 1), ascribed by Oldenberg (rather doubtfully) to the union of Cl^{+} and Cl^{-}. The arrows indicate the approximate positions of the middle band of the new spectrum about 385 $\mu\mu$; about a dozen of these bands can be made out on the photographs, the interval being about 10 $\mu\mu$; they fade off in intensity about equally on either side of the brightest band, but on the ultra-violet side they begin to exhibit a structure, which, however, cannot be studied with the low dispersion at our disposal.

The new spectrum appears to resemble somewhat, but not to be identical with, one described by L. and E.

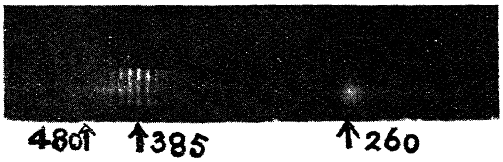

FIG. 1.

Bloch (*Comptes rendus*, **184,** 744; 1927) obtained by passing an oscillatory electrodeless discharge through a tube containing sodium chloride.

The explanation first considered was that the heat of the flame produces chlorine atoms inside the zone of combustion and hydrogen atoms outside. The union of these atoms produces sufficient energy to give rise to radiation in the ultra-violet region, and if this is absorbed by the chlorine molecule might give rise to a resonance spectrum. But the bands are produced in the outer zone of the flame, which points to the molecule of hydrogen chloride as the emitter. The fine structure is being examined with the help of Prof. Curtis of Newcastle.

E. B. LUDLAM.

University Chemical Laboratory,
Edinburgh.

Changes in Nitrocellulose when Exposed to Light.

LORD RAYLEIGH mentions (NATURE, Oct. 27) that celluloid containing malachite green changes to a red colour when exposed to sunlight. He rightly remarks that this change is caused by the nitrocellulose and not by the camphor present in the celluloid. Berthelet and Gaudechon (*C.R.* **153**, p. 1220; 1911) found that oxides of nitrogen are liberated when nitrocellulose is exposed to ultra-violet light. It has also been known for some time that 'solarised' nitrocellulose becomes acid.

The production of the deep red colour is apparently due to the nitrogen oxides liberated, since it can be shown that malachite green (= Victoria green) acquires a deep red coloration with nitrous acid. Nitric acid produces a greenish-yellow colour in dilute solutions. Both colours fade on standing.

It may be of interest to mention that the wavelength most effective (per quantum absorbed) in causing acid decomposition of nitrocellulose is about $\lambda = 3100$ A., and does *not* correspond to the greatest absorption power of nitrocellulose. A more detailed account of the photochemical decomposition of nitrocellulose was given in a recent paper by DeVore, Pfund, and Cofman at the last meeting of the American Chemical Society, and will be published in the near future.

V. COFMAN.
H. B. DEVORE.

E. I. Du Pont de Nemours and Company,
Experimental Station, Wilmington, Del.,
Dec. 5.

The Average Life Period of an Atom.

THE unwary reader of Dr. J. H. J. Poole's letter (NATURE, Dec. 22, 1928, p. 960) would not gather that I had suggested any explanation of the heat conducted out of the earth that is not of radioactive origin. On the theory I have given at various times it is original heat, a relic of the earth's primitive fluid state. When Dr. Poole says, "We can only attribute the remaining 13 per cent to the apparently stable elements," he indicates that he has not read the theory that he appears to be quoting. Allowance for heat due to other sub-atomic changes would decrease the amount due to radioactivity more than that due to original heat.

Dr. Poole also says that "it is only by assuming a rather arbitrary distribution of radioactivity with depth that we can ensure that the earth as a whole is cooling." The upward concentration of radioactive matter is not assumed in order to ensure that the earth as a whole is cooling, but in order to co-ordinate the facts of the temperature gradient in the earth's crust, the radioactivity of surface rocks, and the law of heat conduction. When this is done, the cooling of the earth follows as a consequence: it is not a hypothesis. The alternative hypothesis mentioned by Dr. Poole begins by rejecting the law of heat conduction.

HAROLD JEFFREYS.

St. John's College,
Cambridge.

Ultra-Violet Raman Spectrum of Water.

So far, the study of the Raman effect has been confined to the visible region of the spectrum only. By the use of an all-quartz apparatus similar to that of glass used by Prof. Wood (*Phil. Mag.*, Oct. 1928), I was able to obtain the effect in the ultra-violet region for water in two hours. Fig. 1 shows that for every bright line in the mercury arc spectrum, there is a

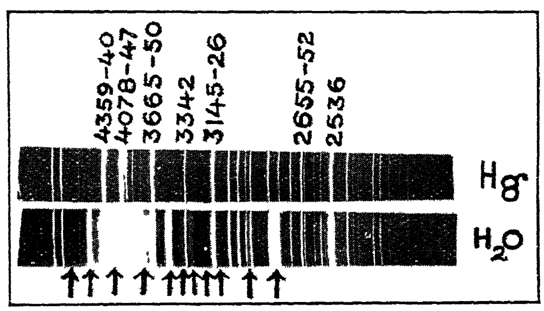

FIG. 1.

Raman band in the spectrum of the light scattered by water. There are altogether eleven bands clearly noticeable in the spectrum, which are marked with arrows. Measurements of the wave-lengths of these Raman bands have shown that water has an absorption band at $2{\cdot}97 \pm 0{\cdot}05\ \mu$, in close agreement with the values ranging from $2{\cdot}95\ \mu$ to $3{\cdot}06\ \mu$ from previous infra-red absorption measurements.

I. RAMAKRISHNA RAO.

Wheatstone Laboratory,
King's College,
Dec. 10.

Repetition of the Michelson-Morley Experiment.

By Prof. A. A. MICHELSON, For. Mem. R.S. (Research Associate, Carnegie Institution), Dr. F. G. PEASE, and F. PEARSON.

THIS investigation was undertaken with the view of making a more accurate test than had hitherto been obtained, and may be divided into three parts as follows :

The first preliminary observations were begun in June 1926. The principle employed was not essentially different from that in the original Michelson-Morley experiment, with the exception that in this investigation the observer was mounted on the apparatus, revolving with it while making observations. Several hundred observations were made, all indicating the same negative result as was obtained in the original investigation. According to calculations furnished by Dr. Strömberg, a displacement of 0·017 of the distance between fringes should have been observed at the proper sidereal times. No displacement of this order was observed.

The second preliminary investigation was begun in the autumn of 1927. In this, the optical parts were supported on a heavy disc of cast iron, floating on a circular mercury trough as in the original experiments. The chief modification, however, consisted in the fact that the light source was placed vertically over the centre of the revolving disc and rotated with it. The return image, by a simple system of reflections, was rendered stationary, thus avoiding the necessity of mounting the observer on the apparatus. The stationary interferometer fringes could therefore be measured in the usual way by means of a micrometer eye-piece, the observer being at rest above the centre of the rotating disc. The length of the light path in this experiment was fifty-three feet.

In consequence of inadequate temperature provision (and probably unsymmetrical strains in the apparatus) the results, while not so consistent as could be desired, still show clearly that no displacement of the order anticipated was obtained.

In the final series of experiments, the apparatus was transferred to a well-sheltered basement room of the Mount Wilson Laboratory. The length of the light path was increased to eighty-five feet, and the results showed that the precautions taken to eliminate effects of temperature and flexure disturbances were effective. The results gave no displacement as great as one-fifteenth of that to be expected on the supposition of an effect due to a motion of the solar system of three hundred kilometres per second.

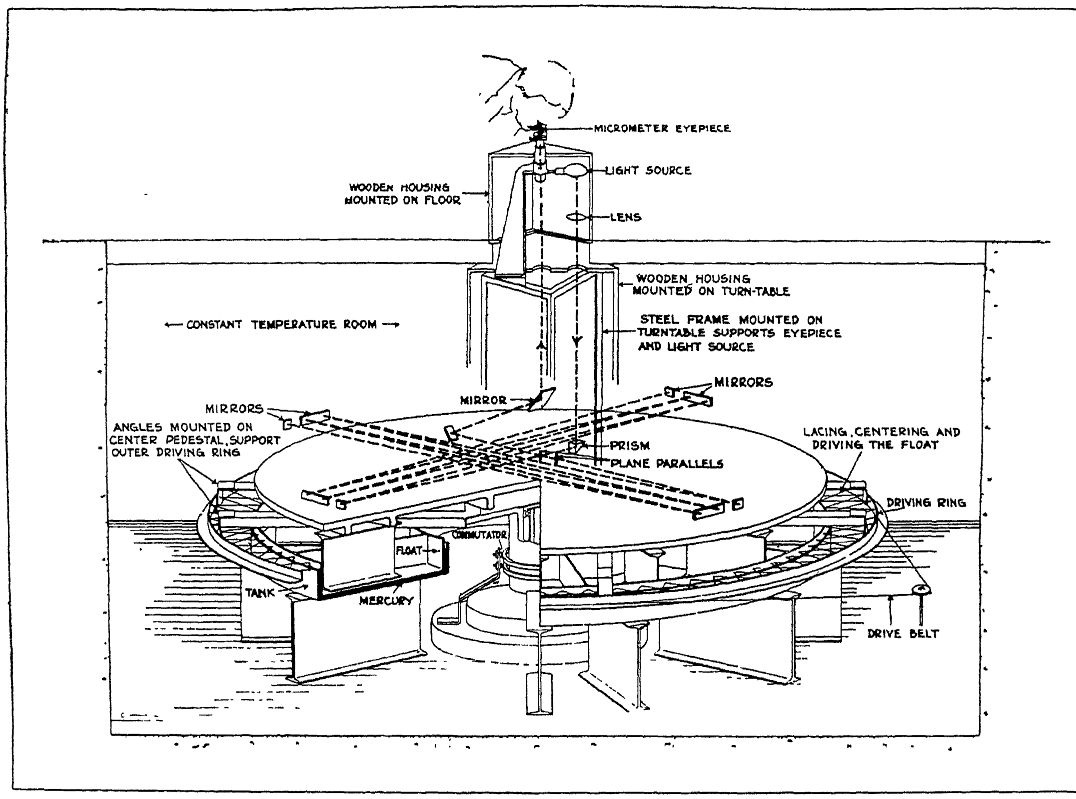

FIG. 1.

These results are differences between the displacements observed at maximum and minimum at sidereal times, the directions corresponding to Dr. Strömberg's calculations of the supposed velocity of the solar system. A supplementary series of observations made in directions half-way between gave similar results.

Progress of the Great Barrier Reef Expedition.

By Dr. C. M. YONGE, Balfour Student, University of Cambridge.

AFTER four months at its headquarters on Low Island, forty miles north-north-east of Cairns, North Queensland, the expedition is now (Nov. 21) well advanced with its extensive programme of research. Excellent living accommodation, and what is in effect a well-equipped marine laboratory, have been erected and fully established. The island has been well chosen as the site of work. Situated midway between the Barrier and the mainland, here only fourteen miles apart, it possesses a fauna characteristic of both these regions ; there is a mangrove swamp with the usual associated fauna and flora, while, exposed on the reef flat at low tides and all around the island beneath low water, there is an abundant growth of corals comprising many genera. There is thus ample material for experimental and observational work, while the island is so small—although thoroughly characteristic of the inner islands or 'cays' which are numerous in the northern portions of the Barrier — that a very detailed ecological survey is possible. The ecological work has been greatly helped by the preparation of a mosaic of the island from a complete series of aerial photographs taken at a height of 2000 feet over the island and reef by an amphibian flying boat belonging to the Royal Australian Air Force. The services of this machine were kindly provided by the Ministry of Defence.

Plankton and hydrographic stations have been taken weekly within the Barrier, at a position three miles east of the island. This work, under the entire charge of Mr. F. S. Russell, who is assisted in his work on zooplankton by Mr. J. S. Colman, is carried out in the *Luana*, a ketch-rigged yacht with a powerful motor, the property of Mr. A. C. Wishart of Brisbane, who is personally in charge of her and is assisted by Mr. C. Vidgen, also of Brisbane. Half-hour oblique hauls are made with the stramin and the coarse and fine silk tow-nets, while vertical hauls are made with the Nansen net. Two similar stations have been taken outside the Barrier, but work there is dependent on the weather; on one occasion a powerful motor launch was hired from Cairns and deep ocean water (150-400 fathoms) was visited. Weekly plankton samples are also taken over the Low Island Reef. A series of hauls, taken in daylight to study the vertical distribution of the zooplankton, showed that, while the surface layers were avoided by most species, there was already a marked increase at 9 metres, the total number of animals rising from 2035 at the surface to 67,822 at 11 metres. A station has also been taken at night to study diurnal changes in distribution.

To date, there have been fluctuations in the zooplankton, but no great changes such as are experienced in temperate waters. It must be remembered, however, that seasons here are far less marked. Similar work on phytoplankton has been carried out by Miss S. M. Marshall, samples of sea water being taken at various depths by means of the water bottle, while vertical hauls with the Apstein net have been taken to compare with work elsewhere. Here, again, the results so far show no startling variations, and the numbers, as compared with British waters, are low. The reason for this paucity in the phytoplankton is revealed by the results of the chemical and hydrographic work carried out by Mr. A. P. Orr. Nutrient salts have been consistently low at all depths, although pH value and oxygen saturation have shown a slight rise throughout since the work was commenced.

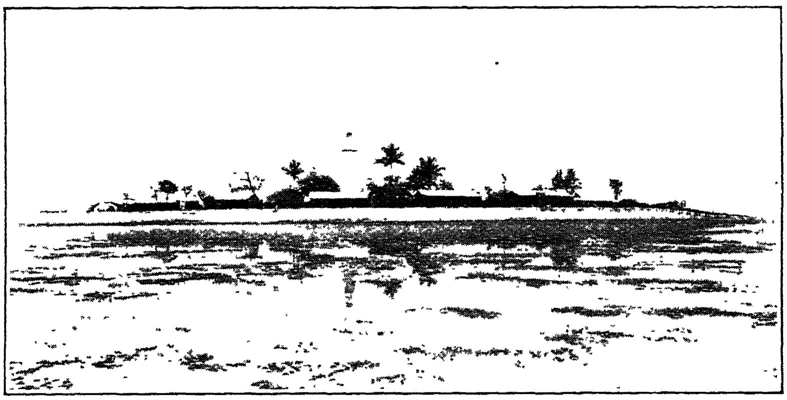

FIG. 1.—View of Low Island from south, taken at low tide. Four huts belonging to expedition are seen immediately behind the beach.

There has also been a gradual rise in temperature and salinity. Outside the Barrier similar results have been found for the upper layers, but, instead of mixing taking place throughout as in the inner station (32 metres), there is a well-marked discontinuity layer between 50 and 100 metres over the 100 fathom line. Temperature, pH value, and oxygen saturation all show a marked fall below 50 metres, but nutrient salts are present in appreciable amounts. Farther out, in deeper water, about 400 fathoms, this was still more marked, at 500 metres the phosphate content being 42 mgm. per cubic metre as compared with between 5 mgm. and 10 mgm. above 50 metres.

A series of samples taken at frequent intervals over a twenty-four hour period from over the reef flat, where there is much living coral, have yielded results of great interest. As soon as the tide leaves the flat at night, there is a rapid fall in pH value and in oxygen saturation, the latter dropping so low as 25 per cent. Open sea conditions are quickly restored when the tide returns. During the day, both pH value and oxygen saturation rise considerably in the pools left by the tide, open

sea conditions again prevailing after the tide has risen. When left by the tide, the temperature of the coral pools rises considerably by day and falls by night, the salinity rising slightly by night and more by day. At a depth of two fathoms in the lagoon among rich coral, the tide has little effect, and the changes are related to light and darkness chiefly.

The work of the reef party under Dr. Stephenson has been varied. He has spent the majority of the first three months in the preparation of an elaborate experiment on the growth rate of corals. One hundred square blocks of concrete have been made, and to each has been fixed one or more living corals of many different genera. The blocks, after being photographed with the corals *in situ* by means of an apparatus which ensures that they can be photographed later at exactly the same angle and distance, have been spiked down firmly in two specially chosen areas. To test the effect of different environments on growth, ten further blocks have been provided with the halves of divided colonies and the halves planted out in different habitats. Dr. Stephenson has examined at regular intervals the gonads of the corals *Favia*, *Symphyllia*, and *Lobophyllia*. All are hermaphrodite, and at present have well-developed ova and less-developed testes. Weekly gonad samples of eight common reef animals, and examinations of the spawn and breeding habits of reef animals, have been made by Mrs. Stephenson. It is interesting to record that the common chiton (*Acanthozostera gemmata*) has twice spawned on the night of full moon. Mr. F. W. Moorhouse, of the University of Queensland, has assisted Dr. Stephenson, and has also carried out intensive work on two species of oyster, two of bêche-de-mer, and on the commercial *Trochus* (*Trochus niloticus*). He is making regular gonad samples of all, while the last named is being farmed for observations on the growth rate, which is remarkably rapid. He is also working on a commercial sponge of fair quality common on this and neighbouring reefs.

FIG. 2.—Outside of laboratory on Low Island.

Mr. G. Tandy, the botanist, has collaborated with the other members of the reef party in the general ecological survey now being carried out, and has also done extensive collecting of marine algæ. He has studied in the greatest detail possible the conditions of plant life on the Low Island Reef, illustrating this with as complete a series of photographs as possible. He has also collected some data on the rate of growth of algæ. There is no *Lithothamnion* reef here or in the neighbourhood, but the ubiquity of encrusting corallines is extraordinary, especially on the lower branches of the common staghorn coral.

While the time of the leader of the expedition has been chiefly occupied with details of administration and matters concerning its efficient running, a good beginning has been made on the intensive study of the feeding mechanisms of corals. The extent to which even corals with the least developed polyps can capture actively swimming planktonic organisms of frequently relatively enormous size is remarkable, while the reversal of the direction of ciliary beat appears to be undoubtedly of common occurrence in corals. Symbiotic algæ in vast numbers have been found in every individual of every genus examined. It is hoped to extend our knowledge of the function of these in the metabolism of the corals. They certainly produce an abundant supply of oxygen; elaborate experiments in which cleaned coral colonies in sealed glass jars have been placed in the sea for periods of nine hours, first in the light and then in the dark, have shown that, whereas in the light the oxygen content of the water may increase by so much as 100 per cent, in the darkness it may decrease almost to zero. The phosphate content decreases to zero usually under both conditions, protein metabolism not being dependent on light. The oxygen and phosphate determinations have been carried out with great accuracy by Mrs. Yonge.

The extent to which the corals with their symbiotic algæ form a closed cycle is revealed by the fact that corals have been kept in sealed glass jars for fourteen days in the sea and have not only lived but the water in some of the jars also contained a higher percentage of oxygen than at the beginning of the experiment. Investigations are proceeding into the part played by the algæ which crowd the exposed mantle surface of the giant clams *Tridacna* and *Hippopus* in the metabolism of these animals.

The effect of starvation and deprivation of light upon the corals and their contained algæ is being studied in the small aquarium attached to the laboratory, a special apparatus having been constructed for this purpose. Investigations of the digestive enzymes of corals show that corals are

(*Continued on p.* 99.)

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The Transition from Live to Dead: the Nature of Filtrable Viruses.[1]

By Prof. A. E. BOYCOTT, F.R.S.,
Graham Professor of Pathology in the University of London.

RUTHERFORD was an example of the danger and folly of cultivating thoughts and reading books to which he was not equal. It is all very well that remarkable persons should occupy themselves with exalted subjects which are out of the ordinary road, but we who are not remarkable make a very great mistake if we have anything to do with them. —W. HALE WHITE, preface to the second edition of "The Autobiography of Mark Rutherford."

I do not propose to enter at length on the old controversy between vitalism and mechanism. Pathologists might with advantage have taken a greater share in it than they have, for it would take a hardened mechanician to maintain his faith in face of our daily experience of repair adaptation and all the other purposive compensations for injury of which the body is so abundantly capable. Unfortunately, our facts have not been widely known to those who have felt inclined to discuss the question. So far as I can see, the attempt to 'explain life by chemistry and physics' has completely failed. It was thought at one time that if only the microscope could be made to magnify enough, we should see life going on. Hope was then transferred to biochemistry, which has done just what the microscope did—it has helped us enormously to understand the mechanisms of live things and not at all to explain life. But if vitalism has had the best of the argument, it has not led to a very profitable or a very satisfactory position. Vitalism is often mysticism, and (which is why mechanism has been so popular) any dualistic interpretation of the world is always repugnant to natural human instincts.

It is possible to escape dualism in another way, and I suggest that the vitalistic controversy in anything like the form it has taken during the last forty years is out-of-date, that instead of emphasising the differences between live and dead things we should make as much as we can of their similarities, and that instead of dividing the world into two distinct categories we should regard it as being made up of one series of units with properties which differ more in degree than in kind. This is not the mechanistic view, for we come to it, not by explaining live things by dead things, but by realising that the characteristics of live organisms appear also in dead matter. While we have been waiting for life to be explained in terms of chemistry and physics, a good deal has been done towards stating chemistry and physics in terms of life. Of course, no 'explanation' of either live or dead has been given; the behaviour of an atom is just as mysterious as the behaviour of a wasp, and neither 'explains' the other any more than a trypanosome explains a whale. But it is something of a comfort if we can believe that at bottom they both behave in much the same way.

ATOMS AND ORGANISMS.

Picking up such rumours as he might of what is going on in other lines than his own, every biologist must have been struck by the curious familiarity of several of the conceptions which in this century have gone to start the revolution in atomic physics which has pulled the universe in pieces and has perhaps not yet quite succeeded in putting it together again. The ideas are familiar because they were originally biological—derived from the study of live things and applied to their explanation. Let me illustrate what I mean by some examples.

(*a*) It is one of the characteristics of life that it is exhibited by discrete units which we know as organisms. As Powell White says, there is no such thing as living matter, there are only live organisms, and in so far as they are alive 0·1 cow or 1·35 cabbage are impossibilities. The live world is made up of such discontinuous pieces: so, we now learn, is the dead world. Fractional atomic numbers are as impossible as fractional animals: the quantum theory tells us that energy is also parcelled out in bits; light consists of particles and, though the ether dies hard, the belief that there is anywhere a continuum—something without a grained structure—has been almost entirely abandoned. Discontinuities—in the

[1] Abridged and revised from the presidential address to the Section of Pathology of the Royal Society of Medicine, delivered on Oct. 16, 1928.

structure of atoms and in the sizes of the stars—are now as characteristic of the dead world as of the live.

(*b*) When Rutherford and Soddy made people believe that one element really could be derived from another, they did for dead things what Darwin had done for live things: indeed they did rather more, for they backed their proposal with experimental proof which neither Darwin nor anyone else had produced in the biological sphere. Now, neglecting the time factor, chemical elements are not necessarily more stable than zoological species. For practical purposes lead is lead and a dog is a dog, but now we have to apply to both the reservation that they have not always been so, and cannot be trusted to be so indefinitely in the future.

The disintegration of the radioactive elements takes place automatically: it cannot be started, stopped, controlled, or modified: its progress is simply a question of the lapse of time. The modes by which organic evolution has been supposed to take place are beyond our discussion, but it is not impossible that it follows the same plan. Osborn and other experts hold that the course of any evolutionary sequence of animals is predetermined from the beginning: this 'orthogenesis' may be interfered with by circumstances and opportunities, for live organisms are obviously liable to meet conditions in this world which they cannot resist, and which may deflect them from a predestined track or bring them to an end altogether: dead elements meet their difficulties elsewhere in the universe.

(*c*) The classification of the elements which has developed by this evolutionary process recalls the familiar schemes of botanists and zoologists which show at once the affinities of animals and plants to one another and (though here there is of course a certain amount of guess work) their phylogenetic relationships. Animals were originally classified by characters which we now believe to be largely immaterial—whales were fishes and bats birds. About 150 years ago comparative anatomy began to get them into more natural groups, and evolution added the criterion of descent in determining the system which prevails at present.

Much the same has happened in classifying the elements into something better than a series of arbitrary pigeon-holes. Their discovery was the first step, much more difficult than the apprehension of animal species. The progress of chemistry then showed that they fell into groups akin to vital genera or families or phyla (we cannot guess at what level the analogy is closest), and the discovery of inorganic evolution and isotopes has brought their relationships to a suggestively biological position. Atomic weights are no longer of any great importance: what matters in classifying an element is its atomic number, which determines its position in the periodic table and is a summary of its comparative anatomy and a clue to its history. An element, for example lead, may arise by more than one line of descent, which is what a biologist would call 'evolution by convergence.' The isotopes into which Aston has dissected many of the elements correspond to the groups of closely allied species which embarrass the systematist and with which bacteriologists are familiar enough.

(*d*) If a man and a bicycle are smashed up together in a common catastrophe, the man mends himself, the bicycle does not. This capacity of self-repair is one of the greatest characteristics of live organisms: indeed, if one wishes to define shortly the subject matter of pathology, I doubt if one can do it better than by saying that it is the study of how organisms resist and repair injury. In the larger, more complicated animals we find very highly developed a capacity for individual repair which we see daily in the post-mortem room and experience continually in our own persons: it is so common that we are not impressed by it as much as we should be. Simpler things, such as bacteria, have little power of personal repair, but they achieve the same ends by other means, and owing to their numerical abundance and their high capacity for reproduction they can allow the injured individual to perish and readily replace him with a new one. Individually or racially, therefore, organisms repair themselves.

Atoms seem to be able to do the same. Each has a definite structure according to its species: as nucleus there are so many hydrogen atoms with their attendant electrons and outside are so many planetary electrons. Electrons are continually being detached from atoms by various means, for example, whenever electrical energy is manifested. Presumably an atom of, say, iron which has lost an electron is no longer of its normal nature and substance, and such a process would in the end lead to the iron becoming manifestly something which was not iron unless some restorative process was at work. It seems clear that injured atoms must be able to pick up electrons from somewhere to replace those which have been lost, a method of individual repair which appears to be efficient enough.

(*e*) Another of the great characteristics of live things is their variability. Any measurable quantity of any organism varies, and the values are distributed in some mode akin to the normal

curve. Crookes suggested long ago that atoms vary in a similar way, Karl Pearson has imagined a world where contingency replaces cause and effect, and Donnan has emphasised that our chemical and physical constants are statistical, derived from the measurement of an infinite number of individuals, and summarising, perhaps, the average values of a variable population: but whether atoms and molecules vary like organisms we do not know—nor is it easy to imagine how we could find out.

(*f*) Cane-sugar boiled with dilute hydrochloric acid is progressively hydrolysed until practically none of it is left. Analysis of the course of the reaction shows that (say) one-fifth of the original quantity is decomposed in the first five minutes, one-fifth of what remains in the next five minutes, one-fifth of what remains in the next five minutes, and so on until the amount left is inappreciable. This strange behaviour is accounted for by assuming that the molecules of cane-sugar go through some sort of regular rhythmical change, so that at any moment only a certain proportion of them are susceptible to the action of the water at the instigation of the acid: there is, I believe, no other justification for the assumption than that it fits the facts, and it cannot fail to remind us of the rhythmical alternations of rest and activity which are common, perhaps universal, in live organisms.

If, as Chick has shown, bacteria sometimes succumb to heat or disinfectants on the same kind of plan, it is legitimate to say that they behave like the molecules of cane-sugar. But it is equally correct to say that the molecules of cane-sugar behave like bacteria. We cannot tell which is imitating the other: all we see is that the behaviour of both is similar. The conduct of the bacilli could scarcely have been predicted from a knowledge of what happened to the cane-sugar. The natural supposition would have been that the molecules of which each bacillus was made up would have been destroyed logarithmically, so that the death point of all the bacilli would have been reached simultaneously—a reflection which illustrates particularly clearly the considerable truth that the discrete unit which is comparable with the molecule of cane-sugar is the whole bacillus and not one of its constituent molecules.

Reproduction.

These analogies between atoms and organisms are suggestive to an imagination which is not afraid to have its wilder moments. There are two general objections which will probably occur at once to most biologists: (1) that dead elements do not show the multiplying reproduction characteristic of organisms; (2) that organic evolution, on the whole, progresses from the simple towards the complex, whereas what I have called the evolution of the elements proceeds uniformly in the opposite direction. The two difficulties are rather closely related.

Organic reproduction does two things: it produces a fresh version of the old organism and it gives an opportunity for numerical increase: its final effect is to leave organisms very much where they were. Each foxglove plant in my garden goes to immense trouble to produce about 500,000 seeds, and the wasps toil earnestly all the summer to increase from one to about 1000. But next year there will be just about as many wasps' nests as this and just about as many self-sown foxglove plants. Darwin taught us the qualitative importance of this superabundance, but, quantitatively, it is made use of only if conditions alter: it then enables organisms to fill up any gap in the environment.

There may be a tendency for a few large organisms to be replaced by many small ones, but on the whole the capacity for reproduction does not result in more organisms than there were before: it merely enables them to adapt themselves to varying conditions. If organisms were less complicated, more stable and enduring, less easily injured and less susceptible to their environment, reproduction might be a less important feature of their activities: an elephant does not bother about it until it is forty years old or thereabouts, a bacillus does it at an age of about twenty-five minutes.

With increasing complexity we get diminishing stability, which is presumably why there is no known element with a more elaborate structure than uranium. Units which are more complex cannot maintain themselves without the periodical remaking which we call reproduction: those which are less complex do not reproduce, because they have no need to do so.

There is no reason to suppose that anything so like organisms as to deserve the same name exists anywhere in the universe except on the earth. But we cannot confine our speculations about dead things within the same limits. The stars are made of much the same elements as the earth, and material transfers take place in both directions: meteorites come and nearly all the hydrogen and methane which arises from the decomposition of cellulose by bacteria and *Streptothrix* flies off to celestial bodies which are dense enough to secure its permanent adherence. The relevant habitat of

the elements is therefore the universe and, taking this into consideration, it is not altogether clear that something like reproduction does not go on in dead things.

Though the elements seem inert and stable enough here and nothing much happens to them except the slow decomposition of those which are, in our environment, radioactive, in the immense heat of the stars atoms not only come to pieces and are dissociated into protons and electrons, but also their basic structure is destroyed, positive and negative electrons fall into one another, and matter is converted into radiation. In the heavens the elements disintegrate more completely than a dead cat does on earth, and unless there is somewhere some reconstruction the cosmos is coming to a material end. Lodge and Millikan think that in the depths of interstellar space, under conditions of intense cold, energy may once again become matter, radiation be reconverted into electrons which in their turn are recombined again into atoms, and so the various elements are reproduced ; Jeans doubts any such regeneration.

The duty of a pathologist does not call upon him to interpose his private judgment in so nice and important a controversy, and it would be impudent to say more than that some such process would enable us to have a comfortable faith in the maintenance of the material universe.

If the elements do go through such a cycle, it is possible that what we call their 'evolution' is more analogous to the death and reproduction of organisms than to the progressive appearance of more complex forms. Very little of the cycle takes place in our own particular corner of the universe, to which the organismal cycle is limited, and it is conditioned by very different circumstances of time and space, but it has much the same result in that it leaves things where they were.

Such are some of the ideas familiar in biology which have appeared in the explanations of our experience of what is not alive. They lead to no certain conclusion ; they furnish, however, an assemblage of concurring and converging probabilities which encourage one to think it possible that things which are alive and things which are not alive constitute in effect one series, beginning with hydrogen atoms and reaching up to man, and perhaps on to angels, not arranged in a continuous linear succession but on a scheme resembling the phylogenetic line of the animal kingdom. The units (or 'wholes' as Smuts would call them) which make up the series are of progressively increasing complexity, structural and functional, and must be compared against one another as they stand, irrespective of their composition. A hydrogen atom, a molecule of albumin, a bacillus, a dog are comparable as such, and it is not necessarily of any moment that hydrogen is the basic stuff of all matter, that proteids are essentials of all live organisms, or that a mammal is made up of many bits, each of which is more or less like a unicellular organism ; in no case is the behaviour of the more complex whole simply the sum of the behaviour of its constituents.

Such a view satisfies our natural antipathy to a dualistic explanation of the universe and makes the old controversy about vitalism and mechanism largely unnecessary.[2] It tells us nothing about the nature of life : by indicating that organisms are analogous to elements, it encourages us to think of life as being as insoluble as gravitation, give up the attempt to make out what it is, and, as Lovatt Evans recommends, spend our time more fruitfully in studying its phenomena. If we like to be paradoxical, we can say that live things are dead, or if we prefer it, that dead things are alive. Both at bottom have much the same characters, and it is unlikely that any sharp distinction between them can be drawn.

Filterable Viruses.

Our general notion of the structure of the universe leads us therefore to expect that we might well meet with things which are not so live as a sunflower and not so dead as a brick, and the phenomena which we study under the heading 'filtrable viruses'[3] suggest that we now have sight of some of this intermediate group. The fluid from a blister in labial herpes, the spleen of a dog with distemper, the blood of a human case of measles or yellow fever, the juice of a tomato plant with mosaic disease, the body fluids of a caterpillar with polyhedral disease, all contain a something which will pass through a fine-grained porcelain filter, is invisible, is destroyed by boiling or strong antiseptics, and will in each case reproduce the disease from which it was derived when it is inoculated into a susceptible animal or plant. Smallpox, vaccinia, rabies, infantile paralysis, foot-and-mouth disease, hog cholera, fowl-pox, and other diseases show the same phenomenon. The bacteriophage is a similar something which dissolves the bacteria with which it is associated : the Rous cancer in fowls yields another invisible agent which will reproduce the same tumour in other fowls.

[2] See J. Needham, *Jour. Philosoph. Studies*, 1928, vol. 3, p. 29.

[3] For a recent survey, including bacteriophage, see "Filterable Viruses," edited by T. M. Rivers (1928) ; for the Rous virus, *Cancer Review, passim*. As Rivers points out, *filterable* for *filtrable* seems to be unauthorised ; on the horrid plural *viruses* see S.P.E. Tract, xix. (1925), p. 36.

If we put the question, Is such-and-such a virus alive or dead ? in the belief that we are asking a crucial question to which there is a definite obtainable answer which would solve our troubles, we put up one of those false antitheses which so often lead us astray. The difficulty in most scientific work lies in framing the questions rather than in finding the answers, and by the time we are in a position to know what the crucial question really is, we have generally pretty well got the answer. In this case ' live or dead ' is a stupid question because it does not exhaust the possibilities. Let us see how far viruses conform with what are, in ordinary language, admittably ' live ' and ' dead.'

Size.—There is no mammal, fish, mollusc, or insect which is not perceptible bare eye any more than there is any bacillus which can be seen without a magnifying glass. It is also in a general way true that there is nothing with the properties which we commonly associate with bacteria which is not at some stage in its life visible with the highest powers of the ordinary microscope.

The rules seem strangely anthropomorphic. Viruses are at or below the limits of microscopic vision (0·2 μ), though just how small they are it is impossible to say. In some phases some of them verge on visibility. They must be ultimately particulate because all matter is so arranged, and from the readiness with which they are adsorbed on to appropriate surfaces the particles are presumably much larger than the molecules of simple salts. Passage through filters with pores of different sizes turns out to be a complicated and dubious method of measurement, and the effects of centrifugalisation may depend more on the specific gravity than the size of the particles : it is possible to concentrate solutions of hæmoglobin in the centrifuge. Taking one thing with another, and reckoning that some viruses are doubtless larger than others, an average diameter of about 25 $\mu\mu$ (0·025 μ) for the smaller ones seems a reasonable assumption, about $\frac{1}{10}$ the diameter of the smallest bacillus, about the same size as the colloidal aggregates of dissolved hæmoglobin and with room for 200 to 400 proteid molecules.

Composition.—A diameter of 0·025 μ does not give much room or many facilities for complicated vital actions. We do not know what occupies that tiny bulk ; we do not even know that viruses are mainly proteid. There would be room for a larger number of simpler molecules, though it is doubtful whether in any simulacrum of life this would compensate for the absence of the unique combination of chemical flexibility and physical stability which proteids possess and without which, so far as we know, ' life ' does not exist. The antigenic quality of viruses (*i.e.* their power to stimulate animals to produce antibodies) is our only evidence that they contain proteid : clinically and experimentally they confer an intense and durable resistance to reinfection which is associated with antiviral properties in the blood-serum.

Metabolism.—The attempts which have been made to demonstrate the production of carbon dioxide by viruses have failed, but the quantities involved are small and the technical difficulties large, so that we cannot regard the evidence as conclusive.

Stability and resistance to harmful agents.—Some viruses at any rate can retain their activity *in vitro* for several years. Some bacteriophages endure for a long time in bacteria-free filtrates ; the Rous tumour virus can be kept almost indefinitely in dried tumour tissue. Others are more labile and are difficult to keep over a period of days. There is much the same variability as there is with bacteria and bacterial toxins : viruses as a class are not characteristically unstable, evanescent things.

A good deal has been made from time to time of their resistance to heat and protoplasmic poisons. Here, again, the results are very various and differ with the sort of virus and the conditions of experiment ; there are no general rules. But there are a remarkable number of instances of viruses which have resisted temperatures up to 75° C., and treatment with chloroform, alcohol, ether, toluol, phenol, acids, alkalis, and so forth. As a whole, they are certainly more resistant than vegetative bacteria, but it is not certain that they differ markedly from bacterial spores. In several particulars their resistance recalls that of enzymes. There is nothing in their size *per se* which should protect them.

Capacity for independent life and multiplication.—No virus has ever been found wild, that is, apart from the animal or plant in which it usually operates, and there is no convincing evidence that any virus has grown and multiplied in artificial culture. Living cells are in all cases necessary, which may be supplied by living bacteria, living animals or plants, or tissue cultures. That they really do multiply under these conditions seems beyond question : foot-and-mouth disease can be passed on from one guinea-pig to another *ad infinitum* by filtrates of blister fluid, the bacteriophage can be transferred indefinitely from one culture of bacteria to another, vaccinia from one calf to another, and so on. All the evidence we have is conclusive on that point. Viruses are certainly not enzymes. Apart from living cells they may for a long time survive,

that is, remain in such a state that, on altering the conditions, they can give rise to their characteristic effect—vaccinia, a sarcoma, bacteriolysis, etc., but there is no evidence that they multiply, and multiplication at the expense of the environment is probably regarded by most of us as the most important criterion of life. For their multiplication, young growing cells are especially suitable, and it may be quite necessary. The bacteriophage multiplies only with the multiplication of the associated bacteria, and vaccinia, herpes, Rous sarcoma, etc., develop and multiply especially in connexion with the growth of cells which results from local injury. Cell injury and cell growth are so intimately related that I know of no case where cell growth can certainly be excluded, but at present we cannot be quite certain that it is necessary. It seems also to be true that viruses multiply only in the course of the production of their specific effect.

Though the fact of multiplication is plain, it is by no means proved that it is effected in the way which is familiar in bacteria and living organisms generally. We put in so much virus and we get out more: we have no evidence, nor, I think, the right to assume, that the particles which we get out are the direct descendants of those we put in.

It may be that these facts are best explained by supposing that viruses are obligatory intracellular parasites, and that the difficulty of cultivating them on artificial media will be solved when we can imitate sufficiently closely the essential features of the intracellular environment.

The Cancer Agent.

Such an explanation would do quite well for the viruses that accompany infectious diseases and would cover the facts for the bacteriophage. But phenomena are known, surely more or less analogous, which it is scarcely possible to regard as due to parasites of any kind.

There is, for example, the agent which induces cells to become malignant, indicated years ago by Haaland and Russell,[4] when they showed that close contiguity with malignant epithelial cells might cause normal connective tissue to grow into a transplantable sarcoma—one of the great discoveries of pathology. Unless we suppose that tumour cells pervert neighbouring normal cells by argument, persuasion, example, or some other sort of immaterial communication, we naturally assume that some substance passes out from the one to affect the other. All attempts to demonstrate this substance in dead tumour cells or in extracts of them uniformly failed until Rous came across his fowl sarcoma and showed that it could be transmitted indefinitely from bird to bird by dried dead cells or by filtrates which contained nothing that could be seen or cultivated. This particular tumour produces the substance in a form so stable that it can be examined and played with when it is detached from live cells. With most transplantable tumours it is present in such small amounts, or more likely in such a labile unstable form, that its clear demonstration is not possible: the carcinoma-sarcoma experiment comes off only with a minority of mouse carcinomas. Gye has shown that its activity may be modified, enhanced, or depressed by various conditions, which helps to explain the difficulties and apparent inconsistencies which are met with in its experimental investigation.

A fair number of tumours have now been transmitted by filtrates, and there is, I think, no reason to doubt that the production of this carcinogenic substance is a common property of all malignant growths. We believe that all pathogenic bacteria, or at any rate all the larger ones, produce extracellular toxins: there is no other way in which they can injure the tissues. But in many instances they are so unstable that it is difficult or impossible to demonstrate their presence apart from the bodies of the bacilli. Nor should we, I think, be too shy of drawing general conclusions from such specially easy and demonstrative examples as Providence has provided for our learning and pushes under our noses, until even our stupidity is bound to take notice: diphtheria and tetanus for toxins, the guinea-pig's peculiar bronchial musculature for anaphylaxis, mice and tar for tumours, and radium are such sign-posts; the Rous tumour is another.

Another analogous phenomenon takes us, I think, a step further. The products of autolysis of dead cells in the body, in suitable concentration, stimulate tissue growth. It is a beautiful self-regulating mechanism in which the amount of stimulus is proportionate to the amount of cell destruction, and therefore to the amount of cell growth required, and it is obviously of the highest importance for survival. As it normally operates in healing our cut fingers, the final result is simply the restoration of the cells which were destroyed.

If the normal restraint exercised by neighbouring tissues is evaded and use made of tissue cultures, the products of autolysis or metabolism (in the form of extracts of tissues, tumours or embryos) stimulate growth indefinitely and a much larger

[4] Third Scientific Report of the Imperial Cancer Research Fund, p. 175, 1908: *Jour. Path. Bact.*, vol. 14, p. 344; 1910.

quantity of tissue may be obtained than we started with. From the autolysis of this a larger amount of stimulating substance may be obtained, and there seems no reason why this process of multiplication should have any limit: normal tissues in the physical isolation of tissue cultures are as immortal as malignant tissues in their physiological isolation from the rest of the body.

No one would, I think, pretend that these products of autolysis are alive in any ordinary sense of the word. They have not received nearly so much attention as they deserve, but they are probably of relatively simple and discoverable constitutions. Yet applied to cells they cause growth, and in so doing potentially increase their own quantity; this is very much what the Rous agent does.

If we agree to put the products of autolysis in the category 'dead,' by what difference are we to separate the Rous virus as being 'alive'? It cannot be cultivated apart from live cells; it multiplies only under conditions where its specific activity is displayed; its inactivation by chloroform and other protoplasmic poisons does not take it nearer life than are toxins or enzymes, or indeed simple metallic catalysts; and its retention of activity after the drastic methods of purification recently described by Murphy seems definitely to exclude it from 'live.' As to its origin, all the evidence seems to concur in indicating that the Rous virus arises *de novo* in each tumour. There is no epidemiological evidence that cancer comes into the body from outside; everything we know supports the classical view that it is a local autochthonous disease.

Most of the experimental work with the virus has started with an actual tumour, and it is therefore just possible that an agent might be carried along through the whole series which originated somewhere else than in a tumour. But experimental sarcomas produced by embryo extract and indol, arsenic or tar have been transmitted by filtrates, and if others have failed to reproduce Carrel's results, I would only remark that, in a question like this, one positive experiment is worth more than a great many negative ones. Epitheliomas are easily produced in mice by tar and in men by chronic irritation, and if we believe that all malignant tumours contain more or less of a carcinogenic agent akin to the Rous virus, it follows that we can with a considerable degree of certainty stimulate normal tissues to produce virus. It is therefore not very remarkable that Murphy, Leitch, and Brebner have at any rate occasionally demonstrated a carcinogenic agent in preparations of normal tissues (testes, pancreas, and embryo *plus* placental extract).

Infectious Diseases.

It is difficult to escape the conclusion that the Rous virus arises in the tumour. There is no doubt that it is a means by which a tumour may be experimentally dispersed through any number of available animals, and it is apparently responsible for some at any rate of the metastases which occur in the course of the natural disease. But there is no evidence that such a virus ever naturally causes a fresh tumour, and we learn the important lesson that the means by which a disease is propagated may not be the same as that by which it was originally started.

The chief way in which the virus of, say, foot-and-mouth disease differs from the Rous agent, and, going a step further back, from the products of autolysis (or metabolism) which stimulate growth, is that it seems to spread about fairly easily from one individual to another: chiefly, I think, from the parallel of bacteria, we take this to imply the possibility of independent life and probably independent multiplication. But we have no direct evidence of this: all we know is that, like the Rous agent, it can be deliberately dispersed through any number of individuals indefinitely, and that it multiplies only when and where it produces its specific effect. The blister which is determined on the foot of an inoculated guinea-pig by slight local injury is pre-eminently the place in the body where the virus is found in the largest amount, and, trying to be as open-minded as we can, we must allow that this may be due either to the lesion being produced where the agent is present in greatest quantity, or to the agent being produced in greatest quantity where the lesion is.

Putting aside all bacteriological analogy, we have no proof that the particles of virus which we get out of the lesion are directly descended from those we put in. In other words, we have to reopen the question which most of us regard as settled: Is the agent the cause of the disease or is the disease the cause of the agent? Another stupid antithesis, for the alternatives are not mutually exclusive: both might be true.

It might well be said—and I think with a good deal of justification—that it is contrary to all common sense to suggest seriously that the viruses of diseases like smallpox, measles, or rabies arise anew in each infected person. It may indeed be nonsense. It is evidently more conformable with our general experience and with the epidemiological dogma to which we subscribe to lay stress on the definite way in which each case can be traced to a preceding case, and that to another, and so on, explaining such

examples of apparently spontaneous origin as we meet with by carriers (who harbour the virus without showing any symptoms) and the imperfections of our data rather than by the concurrence of a favourable epidemic constitution of the atmosphere. With that point of view I quite agree: the evidence that in an epidemic something is passed on from one case to the next seems extremely strong. But at the same time I cannot altogether get rid of the uneasy suspicions which intrude when I think of, say, foot-and-mouth disease, distemper, or labial herpes.

Distemper seems to be everywhere where there are susceptible animals, and if the stock of dogs at Mill Hill can be kept free from it indefinitely, it will be a point of much more than technical interest. As to foot-and-mouth disease, in which no material connexion between one outbreak and another can be discovered, I think that the unbiassed man in the street would say that the facts showed either that the virus was universally dispersed, possibly in some common animal (such as the hedgehog [5]) other than the cow, or that the disease was continually beginning afresh. Labial herpes seems in much the same position. Epidemics may be found by ransacking the literature, but they are certainly not common. Not only has herpes no connexion with itself but also it has a definite association with other diseases —pneumonia and severe catarrhs.

I daresay, however, that some simple explanation will be found for these epidemiological difficulties, and that any suspicions that we may have about the origin of these viruses will be allayed. Viruses can remain dormant in live animals for a long time, and carriers might be activated by a variety of incidents. But what are we to make of such a phenomenon as virus III? Virus III is made manifest by inoculating a filtrate of an emulsion of a rabbit's testis into the testis of another rabbit. This procedure is sometimes followed by an inflammatory reaction and the production of intranuclear 'bodies,' and if this inflamed testis is emulsified and the filtrate inoculated into another fresh rabbit the inflammatory condition is reproduced: thereafter the 'disease' can be carried on indefinitely. It is not fatal, and after its attack has subsided, a rabbit is refractory to further inoculations and his blood-serum can prevent infection with active virus.

[5] Mr. Charles Oldham tells me that at the end of the eighteenth and beginning of the nineteenth century churchwardens in Hertfordshire put as high a price (*4d.*) on the head of a hedgehog as on that of a polecat. 'Urchins' were supposed to do something to cows which diminished the yield of milk, and this was translated into a belief, still extant, that they sucked the cow's udders when they were lying down. Such expenses were not lightly incurred in those days.

If we knew nothing of bacteriology, should we not conclude that this virus had been generated by our procedures from the tissues of the normal testis? The only evidence to the contrary is analogy, and the slender fact that the phenomenon happens more easily in New York than in London rabbits. I do not know how many people have tried similar experiments with other apparently normal tissues: if they had been positive we should certainly have heard about them; Leitch's, Brebner's, and Murphy's successes with sarcoma have already been mentioned and bacteriolysins transmissible in series have been extracted from normal organs.

Whatever filtrable virus we think of, we meet with the same difficulties. A good many people are willing to believe that the bacteriophage is generated by its bacillus—which is probably the truth. They would explain the way in which each bacteriophage more or less fits its own bacillus by its having originated from that bacillus. Others see in their multiplicity evidence that bacteriophages are really live organisms with the characteristic variability and adaptability. It is perhaps more than a coincidence that it is in another group of plants that the same difficulty has arisen: the agents of plant mosaic diseases have never been found apart from affected plants; they have not been cultivated; no one can be sure whether there is one virus or many viruses.

If viruses do originate in tissue cells, what are we to imagine that they are? Béchamp's ghost would answer 'microzymes, as I told you seventy years ago.' Altmann would say bioblasts, others micellæ and even mitochondria, and all the people who have imagined that cells are made up of much smaller essential elementary live particles would see in the present development the fulfilment of their prophecies. They cannot all have been exactly right; bioblasts are quite big, and mitochondria (which some have supposed to be symbiotic organisms) are also visible, and not only to the elect. But it may well be that they were making as shrewd guesses at the truth as Prout did when he suggested that all elements were ultimately compounded of hydrogen. Until Harrison did it, we had not suspected that the cells of warm-blooded animals could be cultivated *in vitro*. If they can live and multiply, divorced from their proper community, is it altogether impossible that parts of cells might have something of a separate existence also, just as electrons may operate apart from atoms?

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specialised carnivores, and the manner—if any—whereby the algæ are digested is yet to be ascertained.

Mr. A. G. Nicholls, of the University of Perth, besides rendering great assistance to the leader of the expedition with his work on corals and beginning work on the calcium content of sea water, has taken charge of the work on the life history of the 'black-lip pearl oyster' (*Meleagrina margaritifera*). An area on the reef flat has been marked off with a stout fence of mangrove wood, ample settling surface for spat being provided not only by the mangrove stakes, but also by numerous empty clean clam shells. Some 450 oysters have been placed in this enclosure. Gonad samples are taken fortnightly, and one breeding period, during the first week in November, so far noted. Mr. G. W. Otter is carrying out a survey of the varieties, numbers, distribution, and powers of destruction of the rock borers, especially the lamellibranchs, and is obtaining results of interest. He is also working on the wood-boring Teredinidæ.

Collecting both on the reef and from the bottom near reefs by dredges and the Agassiz trawl—the latter from a 20-foot whale-boat with a 6 h.p. engine purchased locally—has proceeded apace, but intensive collecting is being held over until after the summer, when it is hoped that an additional boat will be chartered, and excursions can be made far afield. For the time being, the expedition is doing its best work by concentrating on the intensive study of the conditions on and around this small reef, and from the various lines of research so vigorously being prosecuted there is every indication that, at the end of the year here, there will be available for publication the most complete account to date of the conditions under which this type of coral reef exists.

Mr. J. A. Steers, assisted by Mr. M. Spender and Mr. C. Marchant, who constitute the geographical section, have cruised northward from Townsville in a launch chartered there, to Flinders Islands (north of Cooktown) and back, calling at Low Islands for several days on both outward and return trips. They have examined many reefs and coral cays in this long stretch, and have been able to form a very clear idea of the vastness of the problem confronting geographers in this region. Mr. Steers is now on his way back to England, but Mr. Spender and Mr. Marchant are to arrive at the Island shortly, the latter for two months only, the former, with periods of surveying on selected cays and on the mainland opposite the island, for the remaining period of the expedition.

Obituary.

PROF. BASHFORD DEAN.

DR. BASHFORD DEAN, who died at Battle Creek, Michigan, U.S.A., on Dec. 6, 1928, was equally eminent as an ichthyologist and as a student of medieval armour. He acquired both interests in early boyhood in circumstances which fostered them, and he continued to pursue both until the end. For several years he was the active curator of fishes in the American Museum of Natural History, New York, where he planned the public exhibition of fossil and existing fishes. For a still longer period he was curator of arms and armour in the Metropolitan Museum of Art, New York, and likewise planned the installation of the collection. In each case he largely added to the collection by the acquisitions he obtained during his numerous and extensive journeys in the Old World.

Dean was born in New York on Oct. 28, 1867, and was educated first at the College of the City of New York, where he made good progress in zoology. Next, in 1886, he entered Columbia College, where he studied geology and fossil fishes under Prof. J. S. Newberry, whose researches on Devonian fishes he afterwards continued. In 1890 he graduated as Ph.D. with a thesis entitled "Pineal Fontanelle of Placoderm and Catfish," which was published by the New York State Commission of Fisheries. Meanwhile, he had already become tutor in natural history in the College of the City of New York, and had also been appointed assistant on the Fisheries Commission. He thus had early experience both of teaching and of research. In later years he was for a time one of the professors of zoology in Columbia University, where he had some brilliant pupils; but most of his energies were devoted to research and the enlargement of the collections of which he had charge.

Dean's training led him to take the widest view of ichthyology, and he was equally well versed in the methods of embryology and of palæontology. His outlook is well shown in his useful handbook on "Fishes, Living and Fossil," which was published in the Columbia University Biological Series in 1895. It deals mainly with the lower and older groups of fishes, which are of the greatest interest from the evolutionist's point of view. It regards them in all aspects, and facilitates comparisons by adequate synoptical tables and pages of clear figures drawn by himself. It summarises the knowledge and ideas of the time, expressing several opinions which Dean's own researches afterwards caused him to modify. His latest and most important volume, on "Chimæroid Fishes and their Development," published by the Carnegie Institution of Washington in 1906, displays the same wide scope. It combines embryological observations on specimens which he collected in Japanese seas with extensive anatomical research and numerous descriptions of important fossils. It reaches the conclusion now generally accepted, that the chimæroids are highly specialised sharks.

Among Dean's papers on fossil fishes may be specially mentioned those on the Devonian shark which he named *Cladoselache*, and those on the armoured Devonian fishes commonly known as Arthrodira. He showed that the fins of *Cladoselache* could only be explained on the theory that

the fins of fishes had been derived from continuous fin-folds. He also proved that the body-cavity of this primitive shark extended backwards almost as far as the tail fin, by examining microscope sections of the fossil which revealed the structures of the kidney. His researches on the Arthrodira led him to the conclusion that they were not Dipnoi, but while recognising them as much more primitive fishes, he failed to discover their connexion with ancestral sharks which Stensiö has lately demonstrated. Dean also devoted much attention to the supposed Devonian lamprey *Palæospondylus*, which he regarded as wrongly interpreted: he thought it might be the larva of some larger fish.

Dean made many observations on the embryos of all the existing ganoid fishes, the Port Jackson shark, and certain hag fishes, besides the chimæroid fishes already mentioned. He prepared series of beautiful drawings, but many still remain unpublished. His memoir on the embryology of *Bdellostoma stouti*, contributed to Carl von Kupffer's "Festschrift" in 1899, may be specially mentioned as illustrated by some of his finest drawings.

Dean also took every opportunity of studying living fishes, and he made many important observations on the specimens of *Ceratodus* living in the London Zoological Gardens, which were published in the *Proceedings of the Zoological Society* in 1906 and 1912.

From the beginning of his career, Dean realised the difficulty of becoming acquainted with existing knowledge of his subject, and devoted much time to the preparation of an adequate bibliography. By 1910 this had become so unwieldy that he felt he could not complete it himself, and he then succeeded in obtaining the co-operation of the American Museum of Natural History for the final preparation and publication of the work. Under his general direction, the two volumes of the index to authors and titles were extended and edited by the late Dr. C. R. Eastman, and published in 1916–17. The third and final volume, extended and edited by Dr. E. W. Gudger with the co-operation of Mr. A. W. Henn, includes an exhaustive subject index, and was published in 1923. This great work of reference, which extends to the year 1914, is of inestimable service to ichthyology, and gained for Dr. Dean the D. G. Elliot medal of the United States National Academy of Sciences, immediately on its completion.

In 1893 Bashford Dean married Miss Alice Dyckman, who belonged to one of the oldest Dutch families of Manhattan Island, and his wife not only furthered his life-work by her sympathy and help, but also accompanied him on his numerous and extensive travels. He was as well known among the zoologists of Europe as among those of North America, and he had a large circle of friends in Britain. He was a corresponding member of the Zoological Society of London. His always delicate health handicapped him in his activities, but his enthusiasm never flagged, and his old-world courtesy and friendliness endeared him to all who were associated with him. A. S. W.

Prof. E. H. L. Schwarz.

The death of Prof. Ernest H. L. Schwarz, professor of geology in the Rhodes University College, Grahamstown, leaves South African geology much poorer owing to the loss of his enthusiasm, originality, and ability as a teacher and lecturer. Prof. Schwarz was born in London on Feb. 27, 1873, and educated at Westminster School and the Royal College of Science. His father was a London merchant engaged in the South American trade, but he went to South Africa, being attracted by its mining development, and in 1895 settled in Johannesburg, where he became editor of the *Scientific African*.

Prof. Schwarz was more interested in academic than in applied geology, and in 1896 joined the Geological Survey of Cape Colony and spent nine years in its service under Dr. A. W. Rogers. He investigated the older rocks of Cape Colony, and in co-operation with Dr. Rogers correlated them with those of the Transvaal. During his surveys of the Cape Devonian beds he described the complex folds in the Bokkeveld Series, the glacial beds in the Table Mountain Sandstone, and in an account of a collection of rocks from Tristan da Cunha founded his Flabellites Land for a Devonian continent occupying the South Atlantic and extending northward into the Mississippi Valley. In an account of some Karroo beds he suggested that certain tuffs had been formed by the deep-seated shattering of the granite basement. He made important contributions to the Cretaceous and Kainozoic geology of the eastern Cape Colony, and described Baviaan's Kloof (1903), with the series of tectonic basins which he called 'fault-pits'; he gave the name of the Alexandria Formation to a succession of beds which have been recorded as ranging from the Upper Cretaceous to the Pliocene. He also urged the great influence of marine planation in forming the plateau of the same part of Cape Colony.

In 1905 Prof. Schwarz was appointed to the chair of geology at Grahamstown, and had the opportunity to give play to his interests in the speculative sides of geology and cosmogony, and in his "Causal Geology" (1910) he applied some of the natural corollaries of T. C. Chamberlin's planetesimal theory to later geological history. In connexion with his educational work he prepared an excellent summary of the geology of South Africa and a small work on African geography.

While working in the backblocks of the Cape, Prof. Schwarz had been impressed with the diminution of the agricultural population and attributed it to growing desiccation of the country. The reduction of Lake Ngami from a great lake to a swamp, and later to a bare plain, seemed to Schwarz one effect of a process that was doing widespread injury throughout South Africa. He published his conclusions in 1920 in "The Kalahari, or Thirstland Redemption," in which he advocated the diversion from the Upper Zambezi of some of the flood waters that now rush wasted to the sea. He held that much of the water could be turned back

into the dry valleys and lake basins of the Kalahari and the climate of the interior of South Africa materially improved. The scheme has been set aside as too costly; but Schwarz was probably correct in his views that the Kalahari has suffered by the capture by the Zambezi of some of its rivers and that some of the water could be restored to the ancient channels. He, however, probably exaggerated the effects that would follow from this expensive undertaking.

Prof. Schwarz's book on the Kalahari and its natives, published in 1928, recorded his observations during a canoe voyage across that country when wet seasons had refilled its lakes and rivers and thereby thrown doubt on his theory of the progressive desiccation of South Africa. He also described the natives of the Kalahari, and advanced views which, as usual, were of daring unconventionality. His interest in irrigation projects led to his study of the river system of Africa as a whole, and it was probably in connexion with its problems that he was visiting St. Louis in Senegal, where he died on Dec. 19.

Schwarz's conclusions were often highly speculative, and his great scheme for the irrigation of the Kalahari has been rejected as impracticable; but he has left many contributions of permanent value to the geology of Cape Colony, and his death will be widely regretted owing to his gifts of friendship and the stimulating originality of his views.

J. W. G.

DR. W. G. SMITH.

SCIENCE has lost a distinguished agricultural botanist in the death of Dr. W. G. Smith, who died in Edinburgh on Dec. 8, 1928. Dr. Smith was born in Dundee on Mar. 20, 1866. He graduated in pure science in the University of St. Andrews, and after a short period of teaching in the Morgan Academy, Dundee, became a lecturer in agriculture under the Forfarshire County Council. Later he acted as a demonstrator in botany in the University of Edinburgh under the late Sir Isaac Bayley Balfour. Proceeding to Munich, he took a two years' course of study, gaining there in 1894 his doctorate of philosophy for a thesis entitled "Untersuchung der Morphologie und Anatomie der durch Exoasceen verursachten Spross- und Blatt-Deformationen." This thesis was afterwards translated into Italian. Another result of his sojourn in Munich was his translation of von Tubeuf's standard work on the "Diseases of Plants by Cryptogamic Parasites," which appeared in 1897. On his return from Germany, Dr. Smith became lecturer in botany in the University of Leeds, where he remained for eleven years. In 1908 he was appointed chief of the biology department of the Edinburgh and East of Scotland College of Agriculture. For the last twenty years the College was his headquarters. Recently, under the scheme for the development of research work in agricultural problems, Dr. Smith was appointed advisory officer in agricultural botany to the Board of Agriculture for Scotland.

Three fields in botany attracted Dr. Smith's particular interest, and in each of these he was acknowledged an expert. His earlier training under von Tubeuf gave him a keen interest in researches on the diseases of plants, especially those of concern to agriculture and horticulture. Along with his brother, Robert Smith, who died young, he instituted the first detailed botanical surveys in Britain. Numerous papers dealing with ecological botany appeared from his pen. Amongst these were botanical surveys of Forfar and Fife and of various areas in Yorkshire and Teesdale. He was always in close touch with Warming and other distinguished Continental ecologists. The third field in which Dr. Smith distinguished himself was the study of grassland, especially of hill pastures, including the utilisation of heathland and the eradication of bracken.

These three phases of his work were combined into one harmonious whole, and no one was better fitted from his experience and patient research to act as advisory officer on matters concerning agricultural botany. Throughout most of his career he was engaged in the instruction of students, by whom he was held in the highest regard. Teaching duties, onerous as they were, did not hinder him from pursuing a continuous series of investigations, and the record of his published papers extends from 1894 until 1928.

In 1903, Dr. Smith received the award of the Back Grant by the Royal Geographical Society for research in the geographical distribution of vegetation in England. It is of interest to record that of his four children, two pairs of twins (boy and girl), three have had distinguished university careers, each taking first-class honours, while one is still an undergraduate. The elder son is professor of botany in Grahamstown University, South Africa.

WE regret to announce the following deaths:

Mr. R. H. Cambage, C.B.E., president of the Australian Association for the Advancement of Science and of the Australian National Research Council, and a past president of the Royal Society of New South Wales, on Nov. 28, aged sixty-nine years.

Prof. H. B. Fine, professor of mathematics and dean of the departments of science at Princeton University, distinguished for his work in pure mathematics, on Dec. 21, aged seventy years.

Mr. W. T. Gauss, a grandson of the illustrious German mathematician, Carl Friedrich Gauss, and through his mother a nephew of the noted German astronomer, Friedrich Wilhelm Bessel, on Nov. 14, aged seventy-seven years.

Major-General Sir Gerard Heath, a former chairman of the Building Research Board of the Department of Scientific and Industrial Research, on Jan. 9, aged sixty-five years.

Prof. M. J. M. Hill, F.R.S., emeritus professor of mathematics in the University of London and president of the Mathematical Association, on Jan. 11, aged seventy-two years.

Dr. Alexander A. Maximow, professor of anatomy in the University of Chicago and formerly professor of histology and embryology in the Russian Imperial Military Academy of Medicine, on Dec. 3, aged fifty-four years.

News and Views.

THE Gold Medal of the Royal Astronomical Society has been awarded to Prof. Ejnar Hertzsprung, of Leyden Observatory, for his determination of the distance of the Magellanic Clouds and other pioneering work in stellar astronomy. Prof. Hertzsprung's work is characterised by definiteness and originality; it includes researches in photometry; study of change of period in variable stars; investigations of the spacial distribution of Cepheids and other bodies; special studies of clusters; and researches in celestial spectroscopy. He was the first (1906) to emphasise the evidence for distinction between giant and dwarf stars. His work on the relation between colour, proper motion, and apparent magnitudes of stars has been a noteworthy contribution. His early application (1906) of the theory of radiation to considerations of stellar temperatures led him to be among the first to estimate the angular diameters of stars. He found the key by which Cepheid variables can be used to determine stellar distances. Miss Leavitt at Harvard had found a relationship between the apparent magnitude and period of Cepheid variables in the lesser Magellanic Cloud. Hertzsprung saw that this implied a relationship between actual luminosity and period. He then by means of solar motion deduced the parallax of thirteen bright Cepheids and thus their absolute luminosity, and the constant of the period luminosity relation. He derived the distance of the lesser Magellanic Cloud as 10,000 parsecs. This work was published in 1913, and the method has since been extensively employed by Shapley, Hubble, and others in the determination of the distances of remote clusters and nebulæ.

SCOTLAND has been slow in developing the bird-sanctuary movement. Apart from the fine enclosure of some 40 acres at Duddingston Loch, near Edinburgh, there is no considerable reserve in the country, although the vast areas of the deer-forests have acted in many ways as real reservations. A welcome announcement, therefore, is contained in a leading article in the *Scottish Naturalist* (p. 166, 1928), that a new sanctuary of 70 acres is to be created at Possil Loch, in the neighbourhood of Glasgow. The area is well known to naturalists on account of its wealth of plant and insect life, and the use made of the Loch by birds as a resting-place on their migrations. The extension of Glasgow and the increasing presence of irresponsible marauders, egg-collectors, and bird-nesters has threatened the existence of the marsh as a nature-lover's paradise, so that the natural history societies of Glasgow and related bodies have been compelled to acquire the ground in order to preserve its amenity. They have been generously met by the owners of the estate, and propose to administer the area so that its natural beauty and wild life may best be preserved, while reasonable access will be secured to the public for all time. It is estimated that a sum of £2000 will be required for the purchase and maintenance of this bird and botanical sanctuary, and the Committee appeals for donations, which should be sent to Mr. J. M. Crosthwaite at 207 West George Street, Glasgow.

WE are informed that the appeal for subscriptions to a memorial to the late Sir William M. Bayliss and Prof. Ernest H. Starling has up to the present resulted in a sum which, with interest, and apart from subscriptions which are still arriving, will amount to above £2600. The sum has been contributed principally by personal friends, relations, and pupils of these distinguished physiologists, but very liberal subscriptions have also been received from their admirers in America, various European countries, chiefly Germany, from learned societies, and from various physiologists and members of the medical profession from all parts of the world. A small part of the fund has been employed for the provision of a simple memorial tablet designed by Prof. A. E. Richardson, F.R.I.B.A., bearing their names, which will be erected in the entrance hall of the department of physiology and biochemistry, where it will occupy a suitable place over the bust of Sharpey. A material memorial or an annual lecture would, however, have seemed a smaller thing to Bayliss and Starling than the provision of means whereby young workers of suitable training and ability might be attracted into their chosen subject. The bulk of the sum, therefore, will be used for the creation at University College, London, of a Bayliss and Starling Studentship, which will be open to any graduate in science of any university, or any graduate or undergraduate in medicine of suitable standing, to enable him to spend a year or more in such training in physiology and biochemistry as would fit him for research. For this purpose the sum of £2500 will shortly be transferred to the University of London to be held in trust for the creation of such a studentship. The governing body of University College has agreed to assist this scholarship in a very material way by remitting all fees for instruction and ordinary expenses payable by the selected candidate. It is hoped to make the first award of the scholarship in June of the present year.

THE Zoological Society of London has for a hundred years been a force working for the diffusion of Nature knowledge amongst the people, and during the last quarter of a century its progress has been extraordinary. It is fitting, therefore, that the centenary of the granting of its Royal Charter, which followed three years after the founding of the Society in 1826, should be properly commemorated. It will be celebrated during the present year by a representative gathering of fellows and of delegates of other societies at the annual general meeting on April 29, by an evening reception for the 8000 fellows and their guests in the Gardens during the summer, and by the publication of two interesting memoirs. The first of these is a historical account of the origin and development of the Society and of its general and scientific work, written by Dr. P. Chalmers Mitchell; the second, a list of every species of mammal, bird, reptile, batrachian, and fish that has been exhibited alive in the Gardens since their foundation. The list will include popular and scientific names, as well as a certain amount of synonymy and references to descriptions and figures. Anyone who has regularly used P. L.

Slater's "List" of 1896 will appreciate the labour involved in the new venture, and its potential value for the creation of a common standard of English specific nomenclature.

BOUVET Island and Thompson Island, in the South Atlantic, have been much discussed lately owing to rival political claims and the uncertainty as to the existence of Thompson Island. This island has been searched for several times unsuccessfully since Capt. Norris reported it in 1825. Com. R. T. Gould recently showed that to the north-east of Bouvet Island, centring about lat. 54° S., long. 4° 35′ E., there is an unexplored area of the ocean in which Thompson Island probably lies. The whole problem is reviewed in an editorial article in the *Geographical Journal* for December, which is accompanied by reproductions of Norris's sketches, or copies of his original sketches, now preserved in the Admiralty Library. From the evidence available, the suggestion is made that the land first sighted in 1739 by Captain Lozièr-Bouvet and named by him Cap de la Circoncision was not the Bouvet Island of to-day but Thompson Island. Bouvet placed his cape in lat. 54° 6′ S. and he cruised so far as 54° 40′ S. These positions agree reasonably well with the probable position of the two islands. Bouvet estimated that the extent of land which he saw was forty-five miles, but his sight was continually hampered by mist and ice. It is therefore possible that Bouvet really sighted both islands. Furthermore, it is now clear, as has been previously supposed, that the Liverpool Island of Norris is the same as Bouvet Island. Lindsay Island of Lindsay (1808) is the same island. The problem of Thompson Island is further complicated by the failure of the *Norvegia* to find the island in a recent lengthy search in the area of sea indicated above.

DURING the War, when coal was scarce and its price very high, surplus electrical energy was used to heat boilers. It was found that this not only effected savings in the coal bill but also could be used economically in working electric plant. Two applications of the principle have come into practical use. Small thermal accumulators are used for domestic purposes and boilers are regulated electrically so that they can supply a sudden demand for steam. For heavy loads and voltages exceeding 500, the water itself is used as the resistance when alternating current is available. If the frequency of the supply exceed 15, there is no risk of explosive gases being generated in appreciable quantity. In *Engineering* for Jan. 4, a complete description is given of the electrically heated plant which is made by Messrs. Sulzer Bros. of Winterthur. Pressures up to 16,000 volts can be utilised and so the expense of transformers can be saved. Water containing salts conducts electricity much better than soft water. Water at 59° F. has an average resistance of from 1800 to 6000 ohms per cubic centimetre. At 212° F. its resistance varies from about 500 to 2000 ohms per c.c. and it is about 15 per cent. less at 400° F. Boilers should be constructed with their electrodes completely immersed and connected with the top of the boiler by an insulating tube. If this is not done, sparking occurs to the surface of the water when the voltage exceeds 1000, and this causes the load on the boiler to fluctuate and the electrodes to wear away rapidly. Tests prove that the efficiency of large electric boilers is exceedingly high. For domestic purposes, electric thermal storage presents many advantages. The whole of the heat supply in spring and autumn can be supplied by electrical energy, the coal fire being used only during periods of severe cold.

A FEW years ago broadcast listeners were greatly interested in the technical side of the service, and so were not very critical of its quality. The more one listens the less tolerant one becomes of interruptions and of poor quality service. In continental areas the number of available wave-lengths is rapidly diminishing. The number of high-power stations is being reduced, and the other stations are using wave-lengths which are continually getting shorter in order to prevent being interfered with by other waves. In some countries the broadcasting is being carried out in a haphazard way, and their listeners therefore have not been educated to expect a good service. Hence their broadcast radiations interfere with the high-quality reception demanded by residents in other countries. In a paper read to the Institution of Electrical Engineers by P. P. Eckersley, T. L. Eckersley, and H. L. Kirke, on Jan. 2, this aspect of the broadcasting problem was emphasised. They consider it most unfortunate that the broadcasting problem should be discussed by many as if it were a political and not a scientific problem. In their opinion, the best way of attacking it is to attempt to design an aerial so as to make it a radiator which practically emits only rays which are initially parallel to the surface of the earth. It is the existence of the other rays that are so detrimental to a good broadcasting service. These rays interfere with the service from very distant stations and intensify fading and bad service in the local service area. To obtain horizontal radiation high aerials are necessary. Radio engineers in the past have been chary about using wave-lengths less than 300 metres, as they were afraid that this would in practice seriously limit the service area. As the authors point out, however, it has to be remembered that limitations are inevitable, and it is far better to have a limited service than one which suffers continually from interference.

TRINITY COLLEGE, Hartford, Connecticut, does an interesting thing in the way of encouraging good general reading among its students, who are, one may suppose, roughly of what we call 'university status' in England. A list of recommended books is drawn up in ten classes, ranging from natural science, which is put first, through various types of history, on to various types of literature. These books are actually grouped in one bookcase in the College Library. "Students are expected to do one hundred points of reading in a year, and write up each point on at least half a typewritten page. . . . One hundred pages of ordinary novel reading is credited as one

point," and extra credit is allowed for more difficult subject matter. They must select at least one title from each of eight of the ten classes of book mentioned. Not more that a fifth may be fiction. One would like to know how the plan really works, what the students think of it, and how much they retain of the books thus read. Independent reports from the professorial and the student side would be welcome before we embark on the experiment on any large scale in England, where undergraduates are more mature, less *in statu pupillari* than they are in the United States. For the list itself, one can have nothing but praise. It is admirable alike for what it includes and what it leaves out. It is clearly the work of humane and philosophically minded persons who agree with Comte in putting first in their library 'les œuvres de synthèse,' books on the history and the philosophy of science. But when they mention by name in their preface some of the 'muck-raking' novels which they refuse to include in their list, one might be afraid that they would increase the circulation of the proscribed books in any less well-ordered institution than Trinity College, Hartford.

OPERATIONS at Ur were resumed by the British Museum Expedition in November. The results of the first month's excavation, which were described by Mr. Leonard Woolley in the *Times* of Jan. 11, if less spectacular than those which opened the season last year, are none the less remarkable for the fresh light they throw on the funerary customs of the early Sumerians and the promise they hold out for the immediate future. Last year's work recovered the plan of a king's grave. Now a similar grave has been seen in section, which, as Mr. Woolley points out, is scarcely less illuminating. The first indication of the nature of the evidence which was being brought to light was a layer of reeds extending up to the walls of what appeared to be a small room of mud bricks. Under the reeds were innumerable fragments of clay pots, animal bones, and several human skeletons which lay on a floor of beaten clay. This was clearly a subterranean building, of which the contents were in the nature of a votive deposit. Further examination showed that it lay in a vertical shaft, and was an element in a new form of ritual in which, after the burial of the king and the slaughter of his retainers, votive offerings were placed in the earth at intervals as the shaft was filled in, until finally it was stopped with a subterranean chamber containing offerings. This in turn was covered with earth, and perhaps the whole completed with a funerary chapel as a superstructure.

IN another shaft at Ur, which appears to be that of a queen's tomb, a remarkable series of offerings included a coffin burial, and concluded after a considerable interval in the remains of a funeral feast immediately above the dome-shaped roof of a burial chamber in which were six bodies, four men servants, a maid servant, and the queen in whose honour the tomb had been built. Beside the conventional gold head-dress, the funerary appointments included a pin of unusual type and a gold enamel cylinder seal with scenes of feasting and musicians. The tomb of a small girl had a miniature replica of the conventional gold head-dress.

MR. L. S. B. LEAKEY, who returned to Africa in September last to resume excavations in Kenya with the assistance of a grant from the Royal Society, has made a discovery relating to early man which, if the conditions are as reported in the *Times* of Jan. 12, is of great importance. Mr. Leakey is excavating in a cave known as 'the Gambles' in the Elmenteita district, one of the districts in which his discoveries of previous seasons were made (see NATURE, July 16, 1927, p. 85). This cave shows a stratification of fourteen chronological layers extending from the earliest times down to its modern occupation by the N'dorobo. In the stratum of the second of the African pluvial periods into which the early deposits have been classified, Mr. Leakey has found a complete human skeleton, which is said to have been removed undamaged except for a pickaxe hole in the skull. The skeleton, which was associated with a rich industrial development of tools, was found with the knees under the chin. The type is definitely that of *Homo sapiens*. It is stated that Mr. Leakey believes that this is the earliest predecessor of Aurignacian man yet found, his opinion being based upon the view that the various pluvial periods of East Africa are to be equated with the glacial epochs of Europe. In the stratification of the cave a relatively brief Mousterian occupation follows the second pluvial period, and in the third pluvial period the cave was occupied by a people of an Aurignacian culture, who, however, made pottery. The occurrence of pottery with early types of culture in Kenya had already been recorded by Mr. Leakey; but it suggests caution in accepting a high dating. Nowhere else does pottery occur at so remote a period. Neither here nor in any other area do known conditions suggest why East Africa should be exceptional in this respect.

ON Jan. 15, Dr. F. A. Freeth delivered the first of a course of two lectures which he is giving at the Royal Institution on "Critical Phenomena in Saturated Solutions." Dr. Freeth pointed out that the ordinary 'commonsense' view of solutions is apt to be disturbed at high temperatures and pressures near the critical state. For example, it is generally assumed that pressure will cause a vapour to condense; the reverse phenomenon, namely, the turning of a liquid into a vapour by means of increased pressure, is, however, almost a universal phenomenon, although the conditions under which it occurs are sufficiently remote from those of ordinary life to make it appear singular. If we take a saturated solution of a substance and heat it in a closed space, it may just boil, as does a solution of common salt in water; and it is possible to have two solutions which boil at ordinary temperature, one a solution of, say, sodium nitrate and water, the other a solution of water and the salt. There may be a considerable range of temperature, however, in which it is impossible to obtain a solution of any kind, the best known example being that of anthraquinone in ether. This state of affairs holds

for a very large number of salts and water. It has not received much experimental attention on account of the great practical difficulties of realising the conditions. Finally, it was pointed out that just as a liquid should be caused to vaporise by increase of pressure, so in certain circumstances could a solid.

AT a meeting held in New York on Dec. 27, a new scientific society, the Acoustical Society of America, was formed, to bring together workers in all branches of pure and applied acoustics. Among its activities will be the provision of a medium of publication for papers on acoustics, for which there is acute need; such papers have hitherto been widely scattered. Elected to temporary office were: *President*, Dr. Harvey Fletcher, of Bell Telephone Laboratories; *Vice-President*, Prof. V. O. Knudsen, of the University of California; *Secretary*, Mr. Wallace Waterfall, of the Celotex Company; *Treasurer*, Mr. C. F. Stoddard, of the American Piano Company. A committee was appointed by Dr. Fletcher to consider the details of organisation, and the first regular meeting was arranged for some time in April at Bell Telephone Laboratories.

SIR HUBERT WILKINS, in a dispatch to the *Times* announces that he made a second flight from Deception Island on Jan. 10. He passed southward for about 250 miles looking for an advanced base that would be more favourable than Deception Island. Fog, however, prevented him finding one and forced him to return without adding to his discoveries. He has decided to postpone further efforts until next season, when he hopes to find a base on the continent to the south of the group of islands of which he has proved Graham Land forms part. If he is successful in reaching such a base by ship, Sir Hubert Wilkins will be in a position to try a flight along the edge of the continent towards South Victoria Land. Continuity of land below his line of flight will ensure some possibility of return to his base if engine trouble or other causes should force him to descend.

OWING to various developments which have taken place in connexion with the fertiliser interests of Imperial Chemical Industries, Limited (particularly the formation of Scottish Agricultural Industries, Limited), and to the inauguration by the Government of the agricultural credits scheme, the project which the company had in mind for the inauguration and support of a special Imperial Grassland Association has proved unnecessary and incapable of complete realisation without duplication and overlapping of effort. Lord Bledisloe, who had been invited to become the chief of this new organisation (and who, it will be remembered, relinquished his membership of the Government with that object in view) has retired from his association with the project. While acknowledging Lord Bledisloe's willingness and ability to undertake the work which would have been entailed had the scheme been proceeded with, Imperial Chemical Industries, Limited, realised that it had no alternative but to release Lord Bledisloe, who will continue, however, to act in an advisory and consultative capacity on agricultural questions generally.

AN admirable account of the proceedings of the ninth annual conference of the Apis Club, which was held at Geneva and Berne on Aug. 12–16 last, under the presidency of Dr. Otto Morgenthaler, appears in the *Bee World* for November and December last. The meetings were attended by a number of distinguished workers, of several nations, representing both the practical and research sides of apiculture. Among the various papers read at the conference and published in this journal, Dr. E. Elser's account of the micro-technique involved in investigating the brood food over the last forty years is of special interest to biologists. After discussing the now well-known remarkable work of von Planta, modern methods of determining the constituents of the larval food are described. The next conference will be held in Berlin in 1929, under the presidency of Prof. Ambruster.

THE Council of the Geological Society has this year made the following awards: Wollaston Medal to Prof. F. J. Becke, of Vienna, in recognition of the value of his researches in petrology; Murchison Medal to Dr. C. A. Matley, in recognition of the value of his researches on stratigraphical geology in various parts of the British Empire; Lyell Medal to Dr. A. Morley Davies, in recognition of the value of his researches in invertebrate palæontology; Bigsby Medal to Prof. P. G. H. Boswell, for his valuable researches in sedimentary petrology and stratigraphy; Wollaston Donation Fund to Dr. R. Campbell, in recognition of the value of his researches in Scottish petrology and stratigraphy; Murchison Geological Fund to Mr. L. R. Cox, for his valuable researches in invertebrate palæontology, especially in connexion with the Lamellibranchiata; a Lyell Geological Fund to Mr. C. Edmonds, in recognition of the value of his researches on the Lower Carboniferous rocks of the Whitehaven district; a second Lyell Geological Fund to Dr. E. O. Teale, for his contributions to the geology of Victoria and of Africa.

AT the meeting of the London Mathematical Society, to be held on Feb. 14, at 5 P.M., at Burlington House, Prof. O. Veblen, of Princeton University, will deliver a lecture on "Generalised Projective Geometry." Members of other scientific societies who may be interested are invited to attend.

A VIOLENT earthquake was registered at seismological observatories on Sunday, Jan. 13. The record at Kew Observatory, where the first tremors were received at 0 hr. 14 min. 49 sec. G.M.T., indicates that the epicentre was near the Kurile Islands, Lat. 50° N., Long. 150° E. This location is confirmed by the information received from Bombay, Helwan, and Stonyhurst.

THE Annual Report for the year 1927 of the South African Institute for Medical Research, Johannesburg, by the Director, Sir Spencer Lister, has recently been issued. The work of the Institute comprises routine examinations of material for medical practitioners, as aids to diagnosis, and research work. The last-named included during the year field-work on plague, determination of the types of the tubercle bacillus among

South African natives, investigations on pneumonia, cerebro-spinal fever, effects of dust inhalation, and the estimation and elimination of dust in 'dusty' occupations, and a mosquito survey in Zululand.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant in the technical education branch of the department of the West Riding Education Committee—The Education Department, County Hall, Wakefield (Jan 28). A public analyst and agricultural analyst for the City of Cardiff—The Medical Officer of Health, City Hall, Cardiff (Jan. 31). An agricultural economist at the West of Scotland Agricultural College—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (Jan. 31). A technician in the department of zoology of the University of Edinburgh, for assistance in research and the preparation of microscopic slides for class use; also a museum curator in the same department—The Secretary, The University, Edinburgh (Feb. 1). A research assistant in the Leather Industries Department of the University of Leeds—The Registrar, The University, Leeds (Feb. 4). A bio-chemist at the antitoxin establishment of the Metropolitan Asylums Board—The Clerk, Metropolitan Asylums Board, Victoria Embankment, E.C.4 (Feb. 6). A principal of the Dundee Technical College and School of Art—The Secretary, Technical College, Bell Street, Dundee (Feb. 8). A head of the mechanical and civil engineering department of the Sunderland Technical College—The Chief Education Officer, 15 John Street, Sunderland (Feb. 9). Two appointments in the Forest Service of Burma—The Secretary to the High Commissioner for India, General Department, 42 Grosvenor Gardens, S.W.1 (April 6). A full-time teacher of engineering at the Verdin Technical School, Northwick —TheDirector of Education, Dept. 'C,' County Education Offices, City Road, Chester. Two junior assistants (male) under the directorate of ballistics research, Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18. A secretary to the Pharmacopœia Commission of the General Medical Council—The Acting Secretary, British Pharmacopœia Commission, General Medical Council, 44 Hallam Street, W.1. A junior professional assistant in the Meteorological Office—The Secretary (S.1), Air Ministry, Adastral House, Kingsway, W.C.2. An assistant physicist in the experimental department of the Fine Cotton Spinners' and Doublers' Association, Ltd.—The Chief of the Experimental Department of the Association, Rock Bank, Bollington, near Macclesfield. A physicist for research work in the laboratories of the British Boot, Shoe, and Allied Trades Research Association—The Secretary of the Association, 19 Bedford Square, W.C.1.

Our Astronomical Column.

FORBES'S COMET.—The following observations of this comet were obtained by Dr. H. E. Wood at the Union Observatory, Johannesburg:

U.T.	R.A. 1928·0.	S. Decl. 1928·0.
Nov. 21·07734	$12^h\ 8^m\ 29{\cdot}31^s$	21° 43′ 44·5″
26·07167	12 22 3·48	25 12 47·4
30·07286	12 32 45·00	27 38 48·3
Dec. 1·06356	12 35 22·30	28 12 20·4

Using these in combination with positions obtained at Algiers, Lick, and Yerkes Observatories, Dr. A. C. D. Crommelin has deduced the following elliptical elements:

$$\begin{array}{rl} T & 1928 \text{ Nov. } 5{\cdot}02378 \text{ U.T.} \\ \omega & \left.\begin{array}{l} 196° \ \ 0'\ 13{\cdot}6'' \\ 250 \ \ \ 5 \ \ 19{\cdot}1 \\ \ \ 28 \ \ 54 \ \ 6{\cdot}1 \end{array}\right\} 1928{\cdot}0 \\ \phi & \ \ 67 \ \ 48 \ \ 54{\cdot}2 \\ \log q & 9{\cdot}8723448 \\ \text{Period} & 31{\cdot}9448 \text{ years.} \end{array}$$

(with Ω and i the second and third of the bracketed elements)

The identity with comets 1818 I. (Pons) and 1873 VII. (Coggia-Winnecke) may now be looked on as established. The identity of these two was already considered probable by Weiss and Schulhof, but the observed arcs in 1818 and 1873 were only 4 and 5 days, so the matter remained conjectural. The fact that the period found is much closer to 27½ than to 55 years makes it likely that the comet has made four revolutions since 1818, which would give a mean period of 27·69 years. If this is correct, then the comet 1457 I. (observed by Toscanelli and also in China) is probably the same comet, there being thirteen revolutions between 1457 and 1818, with a mean duration of each of 27·77 years. The following are the elements of this comet, necessarily somewhat uncertain owing to the want of precision of observations at that date:

$$T\ 1457 \text{ Jan. } 18\ 0, \quad \omega\ 194{\cdot}9°, \quad \Omega\ 249{\cdot}7°,$$
$$i\ 13{\cdot}3°, \log q\ 9{\cdot}847.$$

The discoverer of the comet at this apparition is Mr. A. F. J. Forbes, of Rosebank, Cape Town, who is an architect by profession, and treasurer and librarian of the Cape centre of the Astronomical Society of South Africa. He has been engaged for some months in sweeping for comets, using an 8-inch reflector which he constructed himself.

The comet is now in south declination 42°, so it is out of reach of most northern observatories. It is to be hoped that it will be observed over a sufficiently long arc to determine the elements, especially the period, with great precision.

ARGON IN THE SOLAR CORONA.—In NATURE for Feb. 4, 1928, a letter by I. M. Freeman appeared, stating that a number of hitherto unidentified lines in the coronal spectrum had been attributed to argon, and promising further details in a forthcoming paper. This paper has now appeared in the *Astrophysical Journal*, vol. 68, p. 177. The investigation of argon was suggested by the fact that three recurring differences of wave-number between pairs of coronal lines agreed with the three chief term differences in the argon spectrum as investigated by Meissner. Twenty-two unknown lines of the corona are attributed with great plausibility to well-known argon lines, while combination lines of argon account for a further ten. Transitions from metastable states are not involved in these identifications, which is in accord with Eddington's theories. A possible test of these results lies in the fact that two different combinations give a line very close to the bright green coronal line, the separation being about 0·1 A., so that it should be possible at future eclipses to detect the doublet structure of this line.

Research Items.

EXCAVATIONS AT KISH.—Reports on the work of the various archæological expeditions in the field at the opening of the new season are now beginning to come to hand. Among the more interesting of these is Prof. Langdon's letter to the *Times* of Jan. 4, which deals with the work of the University of Oxford Expedition at Kish, which resumed work in November. The first undertaking was to continue the attempt to secure an accurate and complete series of archæological stratifications, which last year had reached modern water level. This has now been carried farther by hydraulic methods down to virgin soil through three metres of wet earth. A scientific classification of the various periods from the beginning of civilisation to the neo-Babylonian period has thus been established. The cavity extends to 14 metres below the pavement of the temple of Nabunidus, dating to the end of the sixth century. The water level has risen nine feet since the foundation of Kish. The lowest stratum, now below water level, shows the monochrome and polychrome painted ware and the deep red ware, with some fine black ware and beautifully made incised black pottery. The first two classes correspond to that found at Jemdet Nasr, 17 miles to the north-east, which has been dated at 3500 B.C. According to Prof. Langdon, it is clear that the proto-Sumerian people, who are the real founders of Kish and the proto-Sumerian cities of Mesopotamia, are really Elamites, and from the evidence now being obtained the foundation of these cities should be placed before 4000 B.C. Seven stages of human history are to be observed in the stratification now laid bare at Kish.

BIRDS AND ENVIRONMENT.—An intensive study of the vertebrate fauna of a small area adjacent to the Missouri River in Kansas, has enabled Jean M. Linsdale to reach some general conclusions regarding the relationship of birds to their environment (*Wilson Bulletin*, September 1928). She discusses the dangers to which birds in the area are subjected, the influence of culture upon birds, and of birds upon culture, seasonal responses, relationship between species, and the changes which result from alteration in the environment. The interrelationships of the birds themselves are sketched in brief, and apart from these it is apparent that at almost every point a weighty factor is the presence of man, whether his interference be directly for or against the birds, or be reflected indirectly in changes in the avifauna due to the spread of civilisation and consequent changes in the character of the country-side. Her conclusions, which are similar to those reached by Ritchie in his study of the Scottish fauna, are, finally, that " the area under discussion probably has a larger bird population than it had when it was entirely in primitive conditions. A few large and conspicuous species are extinct, but many more are found now that were probably not present when the country was settled." It is difficult to reconcile this conclusion with the one prophecy made by the author : " with a greater utility of waste land and other resources, a point may finally be reached when the effect of man's work in this vicinity will be to eliminate nearly all the bird species." Surely this is in direct contradiction with the observed premises, unless it be foreseen that the whole area is to be built over.

ORIGIN OF THE FAUNA OF THE WEST INDIES.—The origin of the West Indian fauna has been a subject of controversy, the alternative views being that the fauna has been derived from the mainland by migration over one-time land bridges, or that the fauna is a chance assemblage which has found its way thither by different methods across the existing seas. Karl Patterson Schmidt, in discussing the " Amphibians and Land Reptiles of Porto Rico," in a detailed monograph, comes down upon both sides of the fence (New York Academy of Sciences—Scientific Survey of Porto Rico and the Virgin Islands, vol. 10, Pt. I, 1928). He considers that the Greater Antilles received their fauna from Central America, probably in Eocene or even pre-Tertiary times, and that the uniformity of the faunas of the larger islands suggests that these were united for a time. On the other hand, he thinks that the Lesser Antillean fauna is derived from South America, that it is a genuinely fortuitous one, and that no land bridge has existed through this chain in Tertiary times. The Porto Rico fauna in particular is simply an impoverished Greater Antillean fauna, and its peculiar characters are due to a process of extinction still continuing, to the isolated position of Porto Rico at the eastern end of the land mass, and to the differentiation of the Porto Rican forms, partly through isolation during post-Pliocene times, and partly to the influence of the mountains of Porto Rico as a centre of differentiation throughout Tertiary times, before island conditions began.

YOLK-ABSORPTION IN A SQUID.—Dr. A. Portmann and Miss A. M. Bidder (*Quart. Jour. Micr. Sci.*, Oct. 1928) describe observations on yolk absorption in the squid, *Loligo*. The yolk, large in amount, is contained in a closed yolk-sac which has no communication with any other organ of the body. The sac is divided, like an hour-glass, into an external and internal part, both almost surrounded by blood spaces, and there is a blood-circulation between the embryo and the external yolk-sac by which nutritive material is transferred from the sac to the organs of the body. Growth of the arm-musculature cuts off the circulation to the external yolk-sac, and at this time the yolk is passed from the outer to the inner sac by regular contractions of circum-oral muscles, so that the internal yolk-sac occupies almost the whole of the body cavity. During these changes the vitelline membrane of the internal yolk-sac, hitherto extremely thin, thickens rapidly, and apparently is actively concerned in the transformation of the yolk. The increase in size of the internal yolk-sac gradually brings the vitelline membrane into close relations with the liver and causes the suppression of the intervening blood sinus (except at the posterior end of the yolk-sac), which for a time has transferred nutritive material from the yolk-sac to the organs. The part of the vitelline membrane in contact with the liver is different from the rest, and here transformed yolk passes into the liver. Absorption of the yolk results in decrease of the internal yolk-sac, which finally is almost surrounded by liver. During this stage the liver has rapidly increased in size, and that part in contact with the active vitelline membrane is clearly different from the rest; and the authors suggest the liver is performing two functions,—that common to the whole organ, as in the adult liver, and another—confined to the cells in contact with the yolk-sac—the transformation of the yolk. They suggest that the transformed yolk, mixed with the digestive secretion of the liver, passes to the pancreas, where it is absorbed into the blood stream.

NOMENCLATURE OF GENES.—Breeding work with the domestic fowl at the Anikovo Genetic Station, near

Moscow, of which N. K. Koltzoff is director, led to the publication in 1926 of an extensive monograph in Russian with an English summary, on the genetics of fowls, written by Serebrovsky, Shivago, and others. The results of this work are abstracted by Dr. L. C. Dunn in *Jour. Hered.*, vol. 19, No. 11. The work aims at an analysis of the different breeds of hens in terms of their genes. Particular chapters are devoted to inheritance of the size of the red blood corpuscles and the catalase content, the genetics of growth and size, and of egg-laying. Another is concerned with the chromosome complexes. In this work, Serebrovsky introduces a new system of symbols (first proposed in 1921), which aims at producing an international method of naming genes, by which the same symbols will be used for the different groups of animals and also for plants. The scheme is to subject every gene to a decimal system of classification, by which it receives a number based on its most characteristic phenotypic character. Genes are first divided into ten classes according to whether they are histological, physiological, colour characters, etc. These are each divided into ten groups, such as intensifiers, inhibitors, modifiers, etc. The numbers so obtained are translated into letters according to an arbitrary table, so that a pronouncable word of four or five letters will result. Thus *tifa* refers to the gene for melanin pigment, and *trage* to the barring factor. When the same system of naming is applied to other groups, such as mammals or flowering plants, difficulties may arise, but there is certainly much need for uniformity in the nomenclature of each group.

FORESTRY IN SWEDEN.—In view of the importance of the world's resources of soft timber and the tendency for the supplies to decrease, it is of interest to note that in an address on forestry in Sweden printed in the *Journal of the Royal Society of Arts* for Dec. 7, Prof. E. P. Stebbing stated that the annual cut does not exceed the increment in that country although fifteen to twenty per cent of the areas felled annually are reforested by direct sowing or planting: the remainder are naturally regenerated. At the same time, he pointed out that, while timber cutting on a large scale is in the forests favourably situated for access and transport, the increment is in young woods which will not be available for timber for many years. In the interior of Norrland and in Svealand, the exploitation of mature and over-mature timber exceeds the increment. In southern Sweden there is a shortage of older timber, but young forest is much in evidence. Considerable progress is being made in reclaiming marsh, heath, and bog for forest land. This is done mainly by the State and the large timber companies, but small proprietors are following the example thus set. More than three thousand miles of forest drains were cut throughout the country in 1925, which gives some idea of the scale on which the problems of the forest lands is being faced. Other aspects of Prof. Stebbing's paper are of value in application to the forest lands of Great Britain.

EXPERIMENTS IN MOUNTAIN BUILDING.—The problem of *échelon* folds and the closely related phenomena of accurate folded mountains have been investigated by T. A. Link in a series of experiments carried out in the geophysical laboratories of the University of Chicago (*Jour. Geol.*, pp. 526-538; 1928). It was found that differential stress transmission in the horizontal plane, through rigid materials bordering incompetent beds, gave rise to *en échelon* folds and arcuate systems, even though non-rotational compression was applied. The same effects were produced in homogeneous materials by applying rotational compression. That is to say, differential stress transmission in geological formations may result from lateral variation in plasticity, rigidity, or competency in general. It is shown that some of the experiments gave results comparable in tectonic structure with that of the Jura mountains. The latter are interpreted as an arcuate system in relatively incompetent beds bordering the outer edge of the competent Nägelfluh conglomerate through which the stresses from the Alps were transmitted.

ORE DEPOSITS OF JAPAN.—For many years Prof. Takeo Kato, of the Tokyo Imperial University, has been occupied with an intensive study of the late Tertiary vulcanism and associated ore deposits of Japan. He has usefully summarised the results of these researches in a contribution to the *Jap. Jour. Geol. and Geog.*, 1928. Volcanic activity is represented by the characteristic succession: (1) Rhyolite and associated tuffs; (2) pyroxene-andesite and associated tuffs; (3) minor intrusive dykes of andesite, porphyrite, etc. Mineralisation took place repeatedly in (1) and (2), and the ores are generally, though not always, cut by (3). Certain basalt dykes cut the whole series and are of the post-Tertiary age. The late Tertiary rocks are regarded as the derivatives of a parent magma cooling under plutonic conditions at a comparatively shallow depth, the mineralising solutions being the residual liquors expelled during a late stage of solidification. The volcanic rocks and the ores are thus consanguineous, the parent of each being concealed in the depths, except locally, where crustal disturbances and erosion have been unusually active.

SEMINOLE OILFIELD, OKLAHOMA.—This oilfield, one of the greatest the world has ever known, has attracted attention not only on account of a prodigious production—200,000,000 barrels to the end of June 1928—but also for many important technical reasons. Recent developments prove that no less than five separate oil-pools occur in this field, known as Seabright, Seminole City, Bowlegs, Little River, and Earlsboro. A geological feature of note is that the main producing horizon, the Wilcox Sand, is of Ordovician age, not younger Palæozoic, the case with the majority of oil-fields in the Mid-Continent region. Some production is also obtained from the Hunter Lime, of Silurian-Devonian age, principally in the Seabright unit. The Wilcox Sand lies at depths ranging from 4000 ft. to 4300 ft., according to well-location; it yields an oil of gravity varying between 0·814 and 0·840. Drilling and production technique in this field have recently been described by Mr. G. Heseldin to the Institution of Petroleum Technologists, and, as might be anticipated, provided much interesting data, having regard particularly to the size of the pools, rock conditions, oil and gas pressures, and general rapidity of development. Much of the drilling is by rotary drill down to depths of 3700-3800 ft., when 8¼-inch casing is set and drilling continued with cable tools, this being practicable owing to the comparatively low pressure of the oil in the sand. Some idea of the intensity of development can be gleaned from an example of one well quoted by the author: this took four days to complete the rig; five days later drilling commenced; in less than fifteen weeks drilling was completed to 4485 ft., 4100 ft. of this being made in 50 days. The drillers work in what are known as 'twelve hour towers' and for seven days per week. The greatest footage made in one 'tower' was 220 feet.

SUPERCONDUCTIVITY.—The September issue of the *Journal de Physique* contains the address on this subject which Prof. de Haas, of Leyden, gave to the French Physical Society in May last. When a metal

such as mercury has its temperature reduced, its electrical conductivity increases in the usual way until the temperature is within a few degrees of the absolute zero—4·2° absolute in the case of mercury—when the conductivity becomes very large. Without any change of temperature, the conductivity may be reduced by the application of a magnetic field in the direction of the current, and on withdrawal of the field the metal becomes again a superconductor. If the field be withdrawn gradually, the superconductivity is acquired in steps, and the steps occur at different fields in different parts of the conductor. The author ascribes this to the formation of filaments of atoms along which the electrons move freely, and not to the presence of free electrons in the spaces between the atoms. Superconductivity is brought about by the facility with which the 2, 3, or 4 electrons of the outer layer of an atom can pass from atom to atom when the irregular movements due to temperature have been reduced.

LIGHTNING AND OVERHEAD ELECTRIC POWER LINES.—The high-pressure overhead systems which electricians are now using to convey electric power from their generating stations to their distributing stations have to be protected against the effects of lightning strokes by safety devices. In the *Westinghouse International Journal* for January, E. Beck describes the methods being adopted and the apparatus used by the Westinghouse Company to find out the exact nature of the disturbance caused by a lightning flash in the immediate neighbourhood of an overhead high-pressure power system. The experiments are being made in the Smoky Mountains of Tennessee, U.S.A. A special research staff is employed and elaborate instruments are used. The disturbance of the voltage of the overhead system when a flash occurs acts on a Dufour cathode ray oscillograph and a photograph of the transient disturbance is obtained. Radio receiving sets and a special form of relay which rings a bell are used for signalling the approach of a storm. The photographic film moves with a velocity of 12,000 feet per minute. It is found, however, that this is only suitable for the measurement of slow lightning transients. In order to get a record of the more rapid effects, a rapid oscillatory motion is given to the electron beam. Another instrument used to locate the position of the stroke is called the ‘ osiso.’ It is used to measure accurately the time between the beginning of the oscillograph transient and the arrival of the noise of the thunder as recorded on a film. Two of these instruments enable the accurate position of the stroke to be found by triangulation. A special form of camera is also used, which enables a photograph of the entire horizon to be obtained. It is hoped in this way to find out the connexion between lightning strokes and the ensuing disturbances on overhead systems.

CIRCUIT BREAKING WITH HEAVY CURRENTS.—The difficulties that have been experienced in switching off very large electric currents in circuits which contain an appreciable amount of inductance have led manufacturers to make many careful experimental researches on the subject. Since 1922 the British Electrical Research Association has been experimenting on ‘ circuit breaking ’ with special reference to the rupture of the arc. A paper giving an introduction to these researches, by E. B. Wedmore, W. B. Whitney, and C. E. R. Bruce, was read to the Institution of Electrical Engineers on Dec. 20. The experiments were carried out at the Carville power station at Newcastle. Three special cases were considered when the separating contact pieces were immersed in oil. In the first case, the arc goes out in a bubble of gas separating the contacts. In the second case both oil and gas are present together; and in the third case the whole path is filled with oil. The last case is an exceedingly rare occurrence, and the second case presents great difficulties, as it is almost impossible to determine the relative amounts of oil and gas present in the path of the arc. Hydrogen is the principal constituent of the gases produced by arcing in oil. It was found that a relatively large proportion of acetylene was produced—in some cases it was as large as 30 per cent. This is much larger than that found by previous investigators, due possibly to neglect of the fact that acetylene is soluble in water. The breaking of an alternating current circuit simplifies the problem of how to prevent the arc restarting once the current has attained zero value. Some interference with the arc is necessary during the flow of current. Merely to increase the speed of separation of the contact pieces or to use magnetic ‘ blow-outs ’ is not necessarily a satisfactory solution. It has been shown to be possible to rupture arcs in air, the current in which is approximately 7000 amperes in value and the potential difference across which is 5500 volts, with a single air gap only $\frac{3}{4}$ inch in length.

IGNITION OF FIREDAMP.—The Safety in Mines Research Board has just issued *Paper* No. 46 on the ignition of firedamp by the heat of impact of rocks, written by M. J. Burgess and R. V. Wheeler. The subject is an important one, because there are a number of examples on record in which the heat or the sparks evolved by falling rocks appeared to be the only possible explanation of certain mysterious colliery explosions. The difficulty has been that hitherto there has been no definite proof that firedamp could be ignited in this way. That proof is supplied in the present paper, in which experiments are described in which a block of siliceous rock was pressed against a revolving wheel made of the same rock, and it was found that ignitions of firedamp could be produced comparatively easily under these conditions and that weak mixtures of methane and air could be ignited more easily than rich mixtures. It was shown that an expenditure of energy of less than 200 ft.-lb. was sufficient in some cases to produce ignition, and that a duration of contact between the rock surfaces of between $\frac{2}{5}$ths and $\frac{3}{5}$ths of a second was sufficient for ignition. The paper is a record of a very valuable piece of work, which will no doubt tend to throw light upon one of the possible causes of colliery explosions.

NEW METHOD FOR MEASURING OSMOTIC PRESSURE.—The experimental study of osmotic pressure is a matter of considerable difficulty. Apart from its importance in biology, a convenient method of measuring osmotic pressure would be of great value in the investigation of dilute solutions, and hence it is interesting to note that a new method is described by R. V. Townend in the *Journal of the American Chemical Society* for November. It can be applied to any non-volatile solute in a volatile solvent, the solution and pure solvent being separated by the vapour phase, which acts as a diaphragm permeable to solvent molecules only. The pure solvent is located within the capillaries of a porous plate and the liquid at the surface of the plate is placed under a tension so that the normal curvature is altered and the vapour pressure reduced. The rates of distillation from solvent to solution are measured under different tensions, and the osmotic pressure, *i.e.* the tension for zero distillation, is obtained by extrapolation of the resulting curve.

Annual Exhibition of the Physical and Optical Societies.

THE Imperial College of Science and Technology, London, was once more the scene of the annual exhibition (the nineteenth) of the Physical and Optical Societies on Jan. 8, 9, and 10. The large number of visitors again testified to the widespread interest in the Exhibition on all sides, and its usefulness to trade and industry was evident by the exhibits, bewildering in their number and variety, of the various sections. The general arrangements were similar to those of last year, and congratulations must once more be offered to Mr. T. Martin as secretary, on the success which attended the Exhibition and to all those responsible in various ways for their unfailing courtesy and helpfulness.

It is impossible in a short description to do justice to every part of the Exhibition, and the only plan that can be followed, therefore, is to mention, so far as possible, some of the exhibits typical of recent developments in research and industry.

In the Trade Section there were eighty-two exhibiting firms. Among their exhibits the following may be mentioned: Messrs. Baird and Tatlock, Ltd., the Sutton photometer bench and a pump with double-acting pistons for aerating aquaria tanks, etc., its special attributes being its silent action and economy in use. Bakelite, Ltd., a new flaked fabric moulding material, particularly resistant to shock. The British Metallising Company, Ltd., had an exhibit illustrating the present and possible uses to scientific instrument manufacturers of their process of producing a metal film or coating firmly adherent to a non-metallic base, on which in turn a large range of non-ferrous metals may afterwards be plated to any desired thickness. The Cambridge Instrument Company, Ltd., the Campbell A.C. Potentiometer (Larsen type); a modified form of the photoelectric microphotometer originally developed by Dr. G. M. B. Dobson, a new portable form of electrocardiograph, and other novelties. The Edison Swan Electric Company, Ltd., various Ediswan battery eliminating devices for wireless receivers and other devices for wireless outfits, and a gas-filled rectifier for heavy currents for charging car batteries. The Foster Instrument Company, the intrascope, a new instrument for internal examination of tubes, bores, and other enclosures in which, by means of a novel optical system, examination of industrial structures can be made in the same way as with the cystoscope on the human body. The Research Laboratories of the Gramophone Company, Ltd., a logarithmic recording galvanometer, by means of which the electrical response curve characteristic of a gramophone pick-up can be obtained photographically and plotted automatically with a logarithmic scale; a demonstration of the vibrations of a membrane type loud speaker by means of lycopodium powder aroused much interest. Messrs. Hilger, Ltd., Dr. Jean Thibaud's grating spectrograph for the study of soft X-rays and of the extreme ultra-violet, in which the ruled grating is so placed that the incident rays fall almost tangentially upon its surface; some samples of pure earths—spectroscopically standardised substances. The Igranic Electric Company, Ltd., the transverse current microphone, the Phonovox electrical reproducing equipment. Messrs. E. Leitz, London, a new pattern ultra-microscope for the investigation of elements in colloids. Marconi's Wireless Telegraph Company, Ltd., a signal strength measuring set with a wave range of 14-5000 metres; a tuning-fork and thermostat unit for maintaining constant frequency in facsimile transmission. The M. L. Magneto Syndicate, Ltd., Coventry, the M-L noise comparator—an instrument designed to give a quantitative measure for noises in industrial mechanism, a direct-reading apparatus which requires no aural observation, and can be operated by an unskilled observer. The National Glass Industry, Dewar's flasks for liquid air, etc., and various experimental glassware. Negretti and Zambra, a new industrial type of ventilated hygrometer, a new recording rain gauge to overcome the difficulties of the self-syphoning type. Siemens Brothers and Co., Ltd., distance thermometers of various types, the substantial construction of these being of particular note. H. Tinsley and Company, a portable electric harmoniser under the patent of Prof. Miles Walker. Messrs. Beck, various new microscopes, including the No. 22 metallurgical microscope. Messrs. Carl Zeiss, London, Ltd., a hand sugar refractometer, and refractometer for the oil and sugar industries. Messrs. Bellingham and Stanley, Ltd., showed a new model critical angle refractometer, quartz spectrographs, etc.

In the Research and Experimental Section there were sixteen groups of exhibits illustrating recent physical research. The Brown Firth Research Laboratories had an interesting demonstration of dyed fabrics, showing in a striking manner the different tints of colour obtained when using container vessels of enamelled iron (taken as standard), copper, iron, nickel, lead, and Firth 'staybrite' steel. Among other examples of the applications of photoelectric cells, the Research Laboratories of the General Electric Company showed an apparatus for the detection of dust or smoke in air or gases. The National Physical Laboratory supplied eleven exhibits, among which may be mentioned Dr. D. W. Dye's interferometer for the examination of the modes of vibration of piezo-electric quartz plates; by means of this apparatus the interference fringes are disturbed by the vibration of the quartz plates and the whole area can be mapped into its nodal and antinodal parts; and a beat tone oscillator as a low and telephonic frequency source of good wave form and constant output for testing purposes; a high temperature resistance furnace and electric radiator by Dr. W. Rosenhain and Mr. W. E. Prytherch, in which the heater elements are of particular note; a method of measuring flame temperature by spectrum reversal by Dr. Ezer Griffiths and Mr. J. H. Awbery. The Air Ministry Section of the Meteorological Office had five exhibits, including a sky-photometer and an electrical wind-direction recorder. Prof. E. W. Scripture, of Vienna, showed a graphic apparatus for the registration of speech, and the strobilion, an apparatus for rendering the frequency of the voice tone visible. Dr. J. H. Vincent showed some experiments in magnetostrictive oscillations at audio and radio frequencies.

In the section devoted to lecture and instructional experiments in physics, Mr. S. R. Humby gave some beautiful demonstrations of experiments by means of a modified Tyndall apparatus, showing that the laws of reflection of light hold accurately for sound—illustrating Lloyd's single mirror fringes, Lippmann's stationary light waves and other effects. Messrs. W. and T. Avery, Ltd., Research Department, had a number of exhibits illustrating the mechanics of the freely suspended beam and of linked weighing mechanisms. Other exhibitors in this section were Mr. J. E. Calthrop, Dr. R. S. Clay, Mr. C. W. Hansell, Dr. L. F. Richardson and others of Westminster Training College, Dr. G. D. West, and the Physics Department of the Wigan and District Mining and Technical College.

The Historical Section again provided an oppor-

tunity for a survey of past development in science, all the more striking for being placed near the exhibits of such modern developments as those of the Igranic and Gramophone and other companies. The exhibits included some examples of scientific instruments to illustrate the work of a series of London instrument makers in direct succession from Christopher Cock (seventeenth century) to Elliott (nineteenth century), contributed by Mr. T. H. Court, among which may be noted Robert Hooke's own microscope; photographs of the original apparatus used by Alessandro Volta in his researches of 1763–1819, exhibited by Mr. Robert W. Paul; and some early and primitive time-measuring devices contributed by the Science Museum, from early Egyptian water clocks to a seventeenth-century turret clock from St. Giles' Church, Cambridge.

The discourses once more attracted keenly interested audiences, whose appreciation was obvious. That on the first evening was delivered by Prof. F. Lloyd Hopwood, whose subject was "Experiments with High Frequency Sound Waves." He made use of a quartz piezo-electric oscillator, the crystals being cut in the form of circular discs with their plane faces parallel to the optical axis and at right angles to an electric or binary axis. This method of producing vibrations is due to Prof. Langevin, of Paris, and many practical applications of it have been made both in peace and war. The quartz discs were immersed in transformer oil contained in glass tanks, suitable arrangements being made for producing both horizontal and vertical beams of sound. The method used in connexion with a horizontal beam was due to Prof. R. W. Boyle, and exemplified stationary waves (obtained by reflection and rendered visible by the striæ formed in dust lying on a horizontal sheet of glass in the path of the beam), interference patterns, defraction effects; attenuation (observed by bringing into action the frictional dissipation of energy due to the viscosity of the oil vibrating in a confined space, achieved quite simply by supporting a second glass plate almost in contact with the fir s; pressure of sound radiation, shown by means o Langevin's acoustic radiometer. Some biological effects brought about by the agency of ultra-sonic sound waves were then described and illustrated by means of slides—a beautiful example being the segregating of the chloroplasts in the fresh-water plant *Nitella*. By making use of a vertical beam of ultra-sonic waves some experiments were shown illustrating phenomena not usually associated with sound. These depend on the effect of pressure due to radiation on the surface of oil, which is strikingly shown by the formation of a mound of oil which erupts drops like a miniature volcano. By plunging vessels of appropriate form into this mound, vibrations of great intensity are communicated to the walls of the vessel, or through the walls to liquids contained in them. By these means it is possible to show cavitation in water; the vaporisation of benzene; transverse vibrations of a solid by the pattern produced in a test tube dusted with lycopodium powder; and the calorific effect by melting a wax ball, which can be made to simulate the descent of a time ball.

On the second evening, Mr. Conrad Beck discoursed on "Lenses." The Greeks, he said, at least as early as 430 B.C., learnt that a piece of glass with curved surfaces could be used as a burning glass, and the derivation of the word 'focus' is from the word meaning 'altar' or place of fire. Text-books treat the focus as a geometric point formed by light entering the lens as a parallel beam. This is incorrect and leads to misconception. The focus of the ancients was a finite spot and not a point. Mr. Beck said that the way to understand the action of a lens is to study how it produces an image, for which three processes are necessary: the production of an image of a spot in the centre of the object on the axis; the direction of the axial rays from spots on the object away from the axis; and the examination of a complete bundle of rays from the marginal spot on the object. The Gallilean field glass, telescopes, periscopes, photographic and projecting lenses were discussed, and the study of the Gauss theory for the invention of new and original types of instruments was advocated. Mr. Beck considers that great attention should be paid to the more elementary principles of image formation before the questions of the correction of aberrations or the considerations of diffraction are investigated.

The lecture on the third evening, entitled "Some Colour Problems in Photo-Engraving," was given by Mr. A. J. Bull, and dealt with the effects in three-colour printing of errors in the selective absorption of the three-colour 'filters' and printing inks. Experiments were shown in which white light was imitated by superposing the colours transmitted by three-colour 'filters,' and it was shown that to obtain a white a larger area of blue filter is required than green, and a larger area of green filter than red—blue, green, red being the order of their increasing transparency. The colours obtainable are, however, fairly pure and close to theoretical requirements, so that screen plate processes give colour photographs which are fairly accurate as to colour but much lower in tone. This was shown by examples with the Lumière Autochrome plate. The ideal double colours which are desirable for the purposes of printing were shown by optical superposition of red and green images to obtain a yellow printing colour, green and blue images to obtain a 'blue' printing colour, and blue and red images to obtain a magenta or 'red' printing colour. These were contrasted with the colours of inks actually obtainable and the inaccuracies introduced were shown. These take the form of darkening blues and greens and a loss of reflected blue light with purples and pinks. The methods used for retouching were indicated; in half-tone work the skill of the colour etchers is such that excellent colour prints can be obtained by them from monochrome originals.

KATHLEEN E. BINGHAM.

Annual Conference of the Geographical Association.

THE annual conference of the Geographical Association was held at the London School of Economics on Jan. 3–5. In addition to the usual business meetings, and some discussions on special problems of the teaching of geography, there were public lectures on some recent research work; and the chief part of the presidential address was also concerned with geographical investigation. The president, Sir H. G. Lyons, gave a concise review of the year's activities and then indicated the vast mass of material now available for geographical study in the reports and maps of the many national and other surveys now at work, and some of the difficulties of access to this material. He suggested that the Association should seek the co-operation of other interested societies in attempts to obtain some satisfactory classification of, and readier access to, this material.

Of the four main papers,[1] three dealt with human

[1] Geomorphological Problems of the Eastern Alps, by Prof. J. Solch. Natural Environment related to Human Activity in the Corn Belt of North America, by Dr. P. W. Bryan. The Balance of Urban and Rural Populations, by Prof. C. B. Fawcett. On Linguistic Frontiers in the Borderlands of German Speech, by Dr. Vaughan Cornish.

geography and only one with a purely physical problem. This is a reversal of the proportions which held good in most geographical work even a few years ago; and it marks the extent to which geographers are now attempting to investigate their central problem of the relations of man to his environment and his modifications of the natural environment. Dr. Bryan gave a vivid account of the cultural landscape of rural central Illinois as it is to-day, after more than half a century's work by a population of skilled agriculturists, under favourable physical, political, and economic conditions, has made that area the heart of the Corn Belt. Here the first settlers, coming from the wooded regions of Western Europe or the Eastern States, chose the forested bottom lands as the most fertile and left the treeless prairie untouched; though their choice was also influenced by the fact that they were dependent on the rivers for bulk transport in the pre-railway period. But the soils of the open prairies, fertilised by the humus accumulated from the annual sod of many centuries and retaining their fertility better than the soils of steeper slopes and wetter bottoms, where also tree growth gave a less quantity of humus, are better than any of the other soils except annually renewed river alluvium; and so the prairies are now the richer farmland. The corn belt is by no means a one-crop area, like so much of the cotton belt and some newer parts of the wheat region to the north-west. The corn (maize) is usually grown for two years of a four-year rotation on the best soils and one year in three on other soils. The specialisation of farms in the use of the corn for sale as grain, or for feeding dairy or beef cattle, or swine, is determined mainly by the relative transport facilities for the more or less rapid disposal of their produce by rail to the cities.

A contrast to this account of a modern adjustment to a particular type of environment was furnished by Dr. Cornish's study of the borders of German speech. The author's thesis was that these borders were, for the most part, fixed at the time when Christianity was adopted by, or imposed on, the several peoples concerned; that the Church estimated carefully, and usually accurately, the territorial limits of the languages in use by its converts, and adapted its organisation of bishoprics and archiepiscopal provinces to those limits; and further, that through this organisation the Church did much to stabilise the boundaries which it had adopted and the languages which it recognised and helped to develop. Thus, on the whole, the boundaries established from the fifth century (in the west) to the thirteenth century (in the north-east) remain to-day. The thesis was illustrated by detailed studies of the linguistic borders in Belgium, Alsace-Lorraine, Switzerland, Tirol, Carinthia, Bohemia, Poland, and Slesvig.

The third paper, by Prof. C. B. Fawcett, was an examination of a particular problem of the distribution of population. The differences of classification in various censuses make it impossible to obtain close and trustworthy comparisons of the proportions of urban and rural populations in many countries. According to such census returns, the urban population ranges from 10 per cent of the total in India to 79 per cent in England, and from 3 per cent in Assam to more than 90 per cent in the southern states of New England. Such numerical comparisons are only possible for part of the last century and for the more advanced countries. The maximum numbers of the urban population are fixed by the surplus food produced by the rural population, in any self-contained region and in the world as a whole, and the possibility of transporting that food to the towns. As a result of the improvement of the tools and technique of agriculture, and of transport, during the last two centuries the urban population is now more than half of the total in most of the lands of western civilisation. These improvements act in two ways, first by reducing the number of workers required to cultivate a given quantity of any crop, and second by enabling almost all the industries other than agriculture to be concentrated in the towns. A study of the numbers of the agricultural workers and the proportions of home-grown foods in Great Britain led to the estimate that under the conditions of this country the rural population, not including therein urban workers resident in rural districts, should number at least 25 per cent of the whole population to make the country self-supporting in regard to its principal foodstuffs.

Prof. Sölch's lecture was accompanied by a number of magnificent photographs of Alpine scenery illustrating the existence of several comparatively plane, though much dissected, surfaces, which he termed 'flats,' at various altitudes in the Alps. He compared these with similar land forms in the British highlands, and appealed for comparative studies and co-operation in the task of investigating the ages of these 'flats' and their relations to different stages in the uplift of the Alps and to glacial and interglacial periods.

These papers will probably be published in full in early numbers of *Geography*, the magazine of the Geographical Association, which is to be issued as a quarterly from now on.

University and Educational Intelligence.

APPLICATIONS are invited by the committee of the Royal Society and the University of Sheffield appointed to administer the Sorby Research Fund, for the Sorby research fellowship, value £500 per annum and tenable for five years. Particulars may be obtained from the Assistant Secretary of the Royal Society, Burlington House, London, W.1.

IN the recent Report of the National Fuel and Power Committee it was stated that the most economic use of fuels is largely dependent on a highly trained personnel. With this in mind, the Governors of the Sir John Cass Technical Institute, Aldgate, E.C.3, are extending their existing courses in fuel technology by an advanced and post-graduate course on "Coal Carbonisation," and the inaugural lecture will be delivered by Dr. F. S. Sinnatt, of the Fuel Research Board, on Jan. 28 at 7 P.M. Admission to this lecture is free.

NEGRO universities and colleges in the United States of America have six times as many students as they had ten years ago. This very striking growth is one of the developments brought to light by a comprehensive survey of 79 institutions for the higher education of negroes recently completed by the United States Bureau of Education. It means that the negro universities and colleges have been growing three times as fast as the others. Their aggregate annual income increased in the same period nearly fourfold. Even now, however, their students constitute only one-sixtieth of the total number of university and college students in the United States, and their incomes amount to only one-fiftieth of the aggregate incomes of all such institutions. Although there has been a correspondingly rapid increase in the number of negroes entering the professions for which preparation can be had only in institutions for higher education, the number of negro doctors, dentists, architects, engineers, etc., is still wholly insufficient to provide all the professional service required by the negro population.

Calendar of Patent Records.

January 21, 1630.—The first patent to contain a direct proposal to raise water by fire was granted in England to David Ramsey, one of the grooms of the Privy Chamber, on Jan. 21, 1630. The patent recites a number of devices of which Ramsey claims to be the inventor, amongst which are "to raise water from lowe pitts by fire; to make any sort of mills to go without the helpe of wind, waite, or horse; to make boates, shippes, and barges to goe against strong winde and tyde; to rayse water from low places and mynes and coale pitts by a new waie never yet in use." No record of the details of these inventions is, however, available.

January 23, 1798.—Chlorine was first suggested as a bleaching agent for cotton goods by the French chemist Berthollet, and was so used by James Watt and others, but the establishment of the industry is mainly due to Charles Tennant of Glasgow, who patented his process for absorbing the gas in lime on Jan. 23, 1798. The patent was revoked four years later on the ground that Tennant was not the true inventor, but a second patent granted to him in 1799 for the production of bleaching-powder by impregnating slaked lime in the dry state with chlorine was more successful, and Tennant's works at St. Rollox, Glasgow, became the largest in the world.

January 23, 1849.—From the middle of the eighteenth century onwards, many proposals were made for the coking and industrial utilisation of peat, but the first large peat distillation factory was started by the Irish Peat Company at Kilberry, Co. Kildare, Ireland, to work the process invented by Rees Reece, for which an English patent was granted to him on Jan. 23, 1849. The process created great interest, and a Government Commission was appointed to investigate its possibilities, but the factory was compelled to close down a few years later.

January 24, 1578.—London was given its first water supply by Peter Morris, who was granted a patent for 21 years for his engine for raising water, on Jan. 24, 1578, and later obtained permission from the City Corporation to pump water from the Thames into the City by means of water-wheels placed in the arches of London Bridge and driven by the tide. The installation, completed in 1582, and enlarged from time to time by the addition of further water-wheels, furnished the City with water for 240 years, and only came to an end with the demolition of the old bridge in 1822.

January 24, 1730.—An important event in the history of chocolate-making was the patent granted to Walter Churchman of Bristol on Jan. 24, 1730, for an invention described as "a new invention and method for the expeditious, fine, and clean making of chocolate by an engine driven by a water wheel." The exact process was kept secret, but on Churchman's death the business was purchased by Joseph Fry, and thus became the starting-point of the well-known firm of J. S. Fry and Sons. The water-wheel was replaced by a Watt steam-engine before 1798.

January 26, 1796.—E. T. Jones, accountant of Bristol, was granted a patent on Jan. 26, 1796, for his "new-invented speedy and effectual method or plan for detecting errors in accounts of all kinds, and whereby such accounts will be kept and adjusted in a much more regular and concise manner than by any other method hitherto known." The patent would not presumably have stood the test of an action in the courts, but it no doubt served as an excellent advertisement for the pamphlet explaining his system, which Jones issued, with a licence to use it, at the price of one guinea.

Societies and Academies.

PARIS.

Academy of Sciences, Dec. 10.—**Maurice Hamy**: A consequence of a property of diffraction by a circular aperture.—**Charles Moureu, Charles Dufraisse, and Marius Badoche**: Autoxidation and antioxygen action. (33) The catalytic properties of antimony, bismuth, and their derivatives, and of some vanadium derivatives. The experimental results are summarised in eight diagrams. The catalytic properties of vanadium compounds were very marked.—**L. Cayeux**: The existence of fresh-water spongoliths in the Gard coal basin. The 'silex' of Doulovy is composed of spongoliths, exceptionally rich in spicules, and proves the existence of fresh-water sponges at a very remote period.—**Gabriel Bertrand and Boje Benzon**: The proportions of zinc in plants used for food. The leaves of plants contain zinc in amounts which increase with the proportion of chlorophyll present. Bulbs (garlic, onion) and seeds contain the highest percentages of zinc.—**Riquier**: A problem relating to the partial differential equation $\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}\right)^n u=f(x, y)$.—**Jean Baptiste Senderens**: The catalytic dehydration of alcohols by alkaline bisulphates. Several dehydrations hitherto carried out with potassium bisulphate can be effected with greater facility with sodium bisulphate. Details of the preparation of cyclohexene from cyclohexanol are given.—**Charles Nicolle, Charles Anderson, and Jacques Colas-Belcour**: The experimental adaptation of recurrent spirochætes to species of *Ornithodora* other than those which transmit them in Nature. The necessary conditions for success in these experiments are that nymphs must be used, since although adults can be infected they are incapable (with rare exceptions) of transmitting the spirochætes by their bites, and to utilise for the infecting meal an animal the blood of which is rich in spirochætes.—Serge Bernstein was elected *Correspondant* for the Section of Geometry.—**Paul Delens**: The calculus of spherical operations.—**Marcel Vasseur**: The deformation of a surface with a conical conjugated network.—**Pierre Rivet**: The contact of skew curves and of surfaces.—**Mandelbrojt**: A generalisation of a theorem of M. Hadamard.—**Florin Vasilesco**: The nature of irregular and regular points and their distribution on the frontier of a domain.—**Belzecki**: Some cases of equilibrium of elasticity of a rectangular prism.—**D. Pompeiu**: A formula generalising Cauchy's integral and its interpretation in hydrodynamics.—**Henri Bénard**: Alternate vortices and the law of dynamic similitude.—**G. P. Arcay**: The influence of vibrations on the rate of chronometers. Vibrations bring about a change in the rate of the chronometer, usually a retardation, and part of this change in rate is permanent. The results of the experiments are given in detail.—**Josef Mikuláš Mohr**: The law of frequencies of the velocities of stars and the relation between the absolute magnitude and absolute velocity for *G*-type stars. The distribution of the frequencies of the absolute velocities of these stars, found by the author for 519 stars, is in agreement with the law of Adams, Stromberg and Jay, resulting from the study of type *K*.—**R. Jarry-Desloges**: The period of the planet Venus. The figure deduced is 23 hours 53 minutes, but this result is approximate only, since it implies no change in the markings on the planet during a terrestrial day.—**E. Pierret**: Oscillators with very short waves.—**G. Grenet**: The Hughes induction balance for the determination of the susceptibility of rocks. By the use of the methods and apparatus of wireless telephony, the sensitiveness of the Hughes

induction balance can be increased to a marked extent. The apparatus requires some tedious preliminary adjustments, but once set up, the determination of the magnetisation coefficient of a rock can be completed in five minutes.—**Paul Soleillet**: The theory of the polarisation of light emitted by fluorescence.—**Mlle. Jacqueline Zadoc-Kahn**: The refractive indices of a mesomorphic substance in the solid state. Details of the measurements of the three principal refractive indices of crystals of para-azoxyanisol. From the results, this is one of the most strongly doubly refractive substances known.—**R. Coustal**: The permanent luminescence of certain crystallised salts of uranium. Uranium salts have a faint permanent luminosity, visible only after the eye of the observer has been in complete darkness for thirty minutes or longer. The effect is shown most strongly by the sulphate, the nitrate rather less, acetate and other salts much less. The explanation is based on energy derived from the radioactivity of the uranium.—**Pierre Auger**: The directions of emission of the photoelectrons.—**A. Boutaric** and **M. Doladilhe**: The electrosmosis of mixtures of electrolytes.—**Pierre Jolibois** and **Pierre Montagne**: A rapid method of calculation of homogeneous dissociations. Application to carbon dioxide. A graphical method is described and illustrated.—**Lécorché** and **Jovinet**: Study of the mechanism of the stabilisation of nitroglycerol powders by diethyldiphenylurea. As soon as the powder becomes acid, the nitrous acid formed is absorbed, giving ethylphenylnitrosamine; the latter can be readily determined by a colour method based on the reaction with α-naphthylamine and hydrochloric acid.—**Albert Portevin**: The action of sulphur dioxide at high temperatures on glasses and basic rocks and a probable origin of sulphate mineral springs. Sulphur dioxide, even when diluted with other gases, at high temperatures attacks basic rocks and glasses superficially, forming the sulphates of the alkalis and alkaline earths. The attack is selective, as in spite of the low proportion of sodium in the rocks attacked, the deposit consists mainly of sodium sulphate.—**J. Fallot**: The northern limit of the subbetic overthrusts between Sierra Sagra and Rio Segura.—**Léon Moret**: The extension of the strata containing *Hemithersitea* and phosphate in the southern slope of the Marrakech Atlas (Morocco).—**Aug. Chevalier**: The origin of the Imbuia wood (Brazilian walnut) of Brazil and the biology of the producing tree, *Phœbe porosa*, belonging to the Lauraceæ family.—**Pierre Dangeard**: The favourable action of potassium iodide on iodovolatilisation. The emission of free iodine by certain algæ is increased by treatment with sea water containing a small proportion of potassium iodide in solution.—**Paul Guérin**: Hydrocyanic acid in lotus. A discussion of the amount of hydrocyanic acid present in varieties of *Lotus*, with reference to possible danger as fodder.—**Serge Yourievitch**: The energetics of the ocular movements.—**G. Hamel** and **J. Feldmann**: The geographical distribution of the Fucaceæ and *Laminaria* on the western coasts of the Iberian peninsula.—**A. Magnan** and **A. Sainte-Laguë**: The experimental determination of the resistance to the forward motion of fishes. The results of a kinematographic study giving true velocities.—**S. Posternak**: A new organic phosphorus compound in the red blood corpuscles. The new compound is probably a diphosphate of α-ketotrioxyadipic acid.—**Y. Manouelian** and **J. Viala**: The spinal marrow, the bulb, the protuberance, and the parasite of hydrophobia.—**Et. Burnet, P. Durand**, and **D. Olmer**: Marseilles exanthematic fever is absolutely distinct from exanthematic typhus fever. The Marseilles fever does not give immunity against typhus (in the ape), and acquired immunity against typhus does not prevent the development of Marseilles fever, thus proving that the two diseases are distinct.—**Camille Nachet**: A new arrangement for the simultaneous registration of three selected images for the production of photographs in colour.

GENEVA.

Society of Physics and Natural History, Nov. 8.—**Pierre Dive**: The existence of a permanent regime of rotation in a heterogeneous fluid with ellipsoidal stratification. The author completes as follows a proposition previously enunciated. Whatever may be the law of variation of the flattening of the layers, there exists a permanent regime of rotation which maintains the fluid in its initial stratification, except perhaps in two extreme cases. Except for this, none of the earlier conclusions requires modification.—**Rolin Wavre**: The lines of force of the field of gravity. Continuing his earlier work, the author deduces two new propositions. (1) If in a portion of a fluid the surfaces of equal density are parallel, they have also a mean constant curvature. (2) If the tangent to a line of force of the field of gravity is stationary at a point, the mean curvature of the surface of equal density passing through this point is equally stationary there.—**Fernand Chodat**: The rôle of plants in the atmometric equilibrium of their phyllospheres. New atmometric researches made at the Linnæus alpine garden show that each plant association creates for itself a specific atmosphere, the phyllosphere. It is the same for each plant. The author gives measurements which express the contribution of different plants in the phenomenon of inhibition of the transpiration of the soil by the herbaceous covering.

Nov. 22.—**A. Borloz**: The volumetric estimation of gold in electrolysis baths. During electrolysis, the concentration of the bath diminishes, and it is desirable to have a method of determination which is both rapid and of sufficient accuracy. The author has adapted Jüpner's method (reduction of the gold in solution by a ferrous salt and titration of the excess of the latter with 0·5 normal permanganate) to the case of baths containing impurities, such as salts of bismuth, antimony, etc.—**E. Joukowsky**: Some observations on the phreatic waters of the Genevan plateau. The author has proved for two points of the same phreatic sheet, situated at a depth of about 25 metres, that the level of this sheet is always comprised between that of the lake and that of its outlet. The curves traced during several months show that the precipitations have no influence on the level of the deep waters. Variations in the level of the lake and previously of the outlet, on the contrary, are felt after a lag of several days.—**Sw. Posternak**: A new organic phosphorus compound of the red blood corpuscles. Pursuing his researches on the blood corpuscles of the horse, the author has been able to isolate in addition to the di- and monophosphate of *l*-glyceric acid, a new dextrorotatory principle, the diphosphate of α-ketotrioxyadipic acid, reducing Fehling's solution. This product is certainly related to hexosediphosphoric acid and probably represents an intermediate stage in the course of the elaboration of lactic acid in the muscle and in other tissues.

SYDNEY.

Royal Society of New South Wales, Sept. 5.—**C. A. Sussmilch, W. Clark**, and **W. A. Greig**: Geology of Port Stephens. The area dealt with is situated immediately to the south of Port Stephens. The rocks occurring here belong to the Kuttung Series, a subdivision of the Carboniferous formation. Much of the Kuttung Series throughout the area is hidden under a

mantle of recent alluvian and blown sand, but the outcrops which do occur consist mainly of igneous rocks (lava flows). These Kuttung lavas fall into three groups as follows: (a) Andesites; (b) toscanites; and (c) rhyolites. The andesites occur near the base of the series, and have associated with them coarse conglomerates; the toscanites form a very thick series of flows upwards of 1000 ft. in thickness. With the rhyolites is associated a thick series of sedimentary strata consisting mainly of tuffs and tuffaceous conglomerates, but containing also thin beds of cherty shales containing fossil plants (*Rhacopteris*, etc.). These facts indicate that the district suffered from intense volcanic activity during the Carboniferous period.—**R. H. Cambage**: The outbreak of springs in autumn. During drought times it is not uncommon to hear of the outbreak of springs in New South Wales between February and June; this has nothing to do with the droughty conditions, but is the result of diminishing evaporation. These springs usually come from swamps, and often stop running during the hot weather owing to the whole of the moisture on the surface of the swamp being evaporated. At Kosciusko there is a small roadside spring which regularly flows a distance of 252 yards during the afternoon while it is in shadow, and at night, but late in the forenoon, owing to evaporation while it is fully exposed to the sun, it can only reach a distance of 160 yards. The outbreak of springs has no bearing on the duration of a drought.

Oct. 3.—**W. F. Blakely**: Description of three new Eucalypts and one new Acacia. Two of the new species of *Eucalyptus* are stringybarks; the other belongs to the Hemiphloiæ group and is allied to the broad-leaved peppermints. The acacia is an interesting alpine species with affinities to *A. podalyricæfolia*.

Official Publications Received.

BRITISH.

Board of Trade. British Industries Fair, 1929, The White City, Shepherd's Bush, London, W.12, February 18th-March 1st. Organised by the Department of Overseas Trade. Special Overseas Advance edition. Pp. xvi+400+Ad. 250. (London: Board of Trade.) 1*s*

Department of Agriculture, Trinidad and Tobago. Witch-Broom Disease of Cacao and its Control. By F Stell; and Note by the Hon. A. B. Carr; Appendix: What is a Fungus? by F. Stell. Pp. 19+2 plates (Trinidad B W.I.: Government Printing Office, Port-of-Spain) 3*d*.

Publications of the Dominion Astrophysical Observatory, Victoria, B.C. Vol. 4, No. 5: The Spectroscopic Orbit of H R 5702 and Velocity and Light Curves of 12 Lacertae. By William H. Christie. Pp 55-65 Vol. 4, No. 6: The Orbits of the Spectroscopic Components of the two Helium Stars H.D. 19820 and H.D. 176853 By J. A. Pearce. Pp. 67-79. Vol 4, No. 7: Two A-type Binaries and the Radial Velocities of 50 Stars By R M. Petrie. Pp 81-95. Vol. 4, No. 8: The Spectroscopic Orbit of H.D. 176819 and a Note on H.D. 185936. By P. M. Millman Pp. 97-101. Vol. 4, No. 9: Two Spectroscopic Orbits and Notes on ν Sagittarii. By J. S. Plaskett Pp. 103-118. (Victoria, B C)

Royal Society of Arts, John Street, Adelphi, London, W.C 2. Report on the Competition of Industrial Designs, 1928 Pp. 46. (London.)

Papers of the Society of Painters in Tempera. Edited by M. Sargant-Florence. Vol. 1: 1901-1907. Second edition, revised and brought up to date with Appendix by the Society of Mural Decorators and Painters in Tempera. Pp. ix+96. (Brighton: The Dolphin Press.) 10*s*. 6*d*.

FOREIGN.

Geology and Water Resources of Palestine. By G. S. Blake. Pp. 51. (Jerusalem Department of Lands) 100 mils.

Annual Report of the Board of Regents of the Smithsonian Institution showing the Operations, Expenditures and Condition of the Institution for the Year ending June 30, 1927. (Publication 2927) Pp. xii+580+99 plates. (Washington, D.C.: Government Printing Office) 1.75 dollars.

Stanford University Publications: University Series. Biological Sciences, Vol. 5, No. 2: The Fossil Fishes of the Miocene of Southern California, Contribution No. 9. By David Starr Jordan. Pp. 16+4 plates. (Stanford University, Calif: Stanford University Press) 50 cents.

CATALOGUES

Catalogue of B.D.H. Fine Chemical Products. (January 1929) Pp. 130. (London: The British Drug Houses, Ltd.)

The Photo-electrical Recording Photometer. Second edition. (Mess 469/II.) Pp. 7. Photograms taken with the Recording Photometer. (Mess 469b.) Pp. 4. (London and Jena: Carl Zeiss, Ltd.)

Diary of Societies.

FRIDAY, JANUARY 18.

TEXTILE INSTITUTE (Lancashire Section) (at Manchester), at 1.15.—J. P. O'Callaghan. Water Softening for the Textile Industries.

BRITISH INSTITUTE OF RADIOLOGY (Medical Members), at 5.—Informal Discussion on Gastro-intestinal Cases.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Anatomy and Evolution of the Human Brain.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at Liverpool University), at 6.—C. Gordon Smith Common Salt.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—J. G Weir: Modern Feed-Water Circuits.

INSTITUTION OF CHEMICAL ENGINEERS, (at Institution of Civil Engineers), at 6.30.—Prof. J. W. Cobb: The Reactivities of Solid Carbon in Fuel Processes (Lecture).

SOCIETY OF DYERS AND COLOURISTS (Manchester Section), at 7.—Dr. S G. Barker: The Standardisation of Fastness of Dyestuffs on Dyed Fabrics.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—M. O. Dell: Some Recent Prints from the Pyrenees.

GLASGOW SOCIETY OF DYERS (at 7 Gordon Street, Glasgow), at 7.15.—A. J. Hall: The Action of Swelling Agents on Artificial Silk.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—J. F. Petree: Notes on the Fitting and Operation of Michell Bearings.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Milton Hall, Manchester), at 7.30.—Dr. J. J. Fox: The Examination of Paints.

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Graduates) (at 51 West Regent Street, Glasgow), at 8.—J. Swan: Dynamometers.

ROYAL SOCIETY OF MEDICINE (Pathology, Surgery, and Obstetrics Sections), at 8.—Special Discussion on Post-operative Thrombosis. Openers: W. H. Evans (Pathology), D. H. Patey (Surgery), V. Bonney (Obstetrics).

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8 30.—C. T. Holland. Epiphyseal Injuries of the Wrist Joint.—Dr. R. S. Patterson: Some Factors Influencing Epiphyseal Growth and Union.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir William Bragg: Further Progress in Crystal Analysis.

TODMORDEN TEXTILE SOCIETY (at Todmorden).—H. P. Curtis: Cloth Testing and Examination from the Manchester Man's View

SATURDAY, JANUARY 19.

GEOLOGISTS' ASSOCIATION (at Museum of Practical Geology, Jermyn Street), at 2.30—Dr. R. Crookall: Demonstration of Coals, their Composition and Origin.

PHYSIOLOGICAL SOCIETY (at National Institute for Medical Research, Mount Vernon, Hampstead), at 3.—Dr. H. H. Dale, H. W. Dudley, H. P. Marks, and J. H. Gaddum: A Choline Ester (?) in Extracts of Spleen.—Prof L. Hill: Sphygmometry of the Vessels of the Frog's Leg.—J. A. Campbell and T. Angus: Water Evaporated from the Body in Relation to Work.—J. A. Campbell: Tensions of Gases in Tissues. (a) Effects of CO Poisoning; (b) Hydrogen in the Peritoneal Cavity.—F. M. Durham: Effect of Alcohol on Genetic Behaviour of Guinea Pigs.—H. V. Horton and W. Dulière. Reversible Loss of Excitability in Isolated Amphibian Voluntary Muscles.—W. Dulière: The Condition of Creatine in Amphibian Voluntary Muscle—D. W. Bronk: The Energy Expended in Maintaining a Contraction—Prof. A. V. Hill: The Restoration of Fatigued Muscle by Washing with Oxygen-free Ringer's Fluid.—H. E. Magee: Further Experiments on the Movements of Isolated Intestinal Loops.—A. N. Drury and A Szent-Gyorgyi: The Influence upon the Heart of a Substance Present in Heart Muscle and other Tissues.—Demonstrations:—J. A. Campbell. (a) Effects of Prolonged Exposure to Low Tensions of Oxygen: (b) Gas Tensions at the Surface of the Skin of Man.—Prof. L. Hill: A Katathermometer Graduated for Warm Atmospheres.—Prof. L. Hill and J. McQueen: Capillary Circulation in Liver of Mouse—R. B. Bourdillon and R. G. C. Jenkins: Methods of Measuring Absorption of Ultra-violet Rays.—A. Eidinow: Sensitisation to Fluorescent Radiation.—Dr. H. H. Dale: Complete Artificial Perfusion of the Liver.—J. H. Gaddum: (a) Use of Richards-Collison Metabolism Apparatus for Thyroxin, etc.; (b) An Outflow Recorder for Rapid Flows.—H. E. Magee and J. J. R. Macleod: Diffusion through the Wall of the Living and Dead Intestine.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. E. Cammaerts: Flemish and Belgian Art (I.): The Portrait.

BRITISH ASSOCIATION OF MANAGERS OF TEXTILE WORKS (at Athenæum, Manchester), at 6 30.—W. A. Hanton. Recent Loom Design (Lecture).

HULL ASSOCIATION OF ENGINEERS (at Municipal Technical College, Hull).—J. Evans: Modern Steam Condensers and Feed Systems.

MONDAY, JANUARY 21.

ROYAL SOCIETY, EDINBURGH, at 4.30.—R. B Mooney and E. B. Ludlam: The Thermal Equilibrium between Ethylene, Iodine, and Ethylene Di-Iodide.—E. B. Ludlam, H. G. Reid, and G. S. Soutar: The Hydrogen-Chlorine Flame.—R W. Armour and E. B Ludlam: Photochemical Equilibrium between Hydrogen, Bromine, and Hydrogen Bromide.—W. W. Taylor: Demonstration of a New Method of Determining Free and Bound Water—W. W. Taylor: The Lyotrope Effect and the Antagonistic Action of Ions.—W O. Kermack, A. G. M'Kendrick, and Eric Ponder. The Stability of Suspensions: III. The Velocities of Sedimentation and of Cataphoresis of Suspensions in a Viscous Fluid.

VICTORIA INSTITUTE (at Central Hall, Westminster), at 4 30—Rev. C. W. Cooper: Precious Stones of the Bible, with Special Reference to the High Priest's Breast Plate.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5—Sir Arthur Keith: The Anatomy and Evolution of the Human Brain.

TEXTILE INSTITUTE (London Section) (at Clothworkers' Hall), at 6.—G. Garnett: Woollens and Worsteds Customs Designation (Lecture)

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London) (jointly with Students' Sections of Institution of Civil Engineers and Institution of Electrical Engineers), at 6 30.—H R. Sketch Engineering Insurance.

INSTITUTION OF AUTOMOBILE ENGINEERS (jointly with Western Centre and West of England Branch of Institution of Mechanical Engineers) (at Merchant Venturers' Technical College, Bristol), at 6.45.—Dr. H. J. Gough: Recent Developments in the Study of the Fatigue of Materials.
INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—Capt. J. M. Donaldson, J. G. Hines, and others: Discussion on The Anticipation of Demand, and the Economic Selection, Provision, and Layout of Plants.
INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—Capt. P. P. Eckersley. Lecture on Wireless.
SOCIETY OF CHEMICAL INDUSTRY (Yorkshire Section) (at Great Northern Hotel, Leeds), at 7.15.—Prof. R. D. Passey: Poisoning and Disease in Industry (II.). Industrial Cancers.
INSTITUTION OF AUTOMOBILE ENGINEERS (Glasgow Centre) (at Royal Technical College, Glasgow), at 7.30.—M. Platt: Safety in Four-Wheel Braking Systems.
BRADFORD TEXTILE SOCIETY (at Midland Hotel, Bradford), at 7.30.—W. O. R. Holton: The Uses of Laps, Wastes, Shoddy, etc. (Lecture).
HUDDERSFIELD TEXTILE SOCIETY (at Huddersfield Technical College), at 7.30.—D. R. H. Williams: Costings (Lecture).
ROYAL SOCIETY OF ARTS, at 8.—Dr. C. H. Lander: The Treatment of Coal (Cantor Lectures) (I.).
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—O. P. Milne: Criticism of Work submitted for Prizes and Studentships. Presentation of Prizes.
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—J. R. Baker: The Northern New Hebrides.

TUESDAY, JANUARY 22.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. F. A. Freeth: Critical Phenomena in Saturated Solutions (II.)
INSTITUTION OF CIVIL ENGINEERS, at 6.—J. H. Hyde and H. R. Lintern: The Vibrations of Roads and Structures.
INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—Capt. J. M. Donaldson, J. G. Hines, and others: Discussion on The Anticipation of Demand, and the Economic Selection, Provision, and Layout of Plants.
ILLUMINATING ENGINEERING SOCIETY (at Home Office Industrial Museum, Horseferry Road), at 7.—Dr. L. C. Martin: Colour and its Applications.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—W. Bickerton: The Moods and Emotions of Birds.
INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates) (at Broadgate Café, Coventry), at 7.15.—Mr. Wheeler: Jigs.
INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates' Informal Meeting) (at Watergate House), at 7.25.—J. F. Ward. The Training of Drivers.
INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Students' Section) (jointly with Newcastle and District Association of Institution of Civil Engineers) (at Mining Institute, Newcastle-on-Tyne), at 7.30.—A. Page: The Development of Generation and Distribution of Electrical Power in the British Isles.
SHEFFIELD METALLURGICAL ASSOCIATION (at Sheffield), at 7.30.—C. H. Faris: The Applications of Electro-deposited Metals to Engineering.
SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Cardiff).—Dr. T. Lewis: The Training of an Ophthalmic Optician.
MANCHESTER ATHENÆUM TEXTILE SOCIETY (at Manchester).—C. A. Harrington: Artificial Silk and its Application to Fabrics (Lecture).

WEDNESDAY, JANUARY 23.

ELECTRICAL ASSOCIATION FOR WOMEN (at 143 Knightsbridge), at 4.—A. B. Read: Modern Decorative Lighting of Interiors.
ROYAL SOCIETY OF MEDICINE (Comparative Medicine and Tropical Diseases Sections), at 5.—Prof. F. T. G. Hobday, Prof. G. H. Wooldridge, Dr. Minett, J. W. McIntosh, E. A. West, and others: Special Discussion on Glanders and Kindred Diseases.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Anatomy and Evolution of the Human Brain.
GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. A. Jowett and Prof. J. K. Charlesworth: The Glacial Geology of the Derbyshire Dome and the Western Slopes of the Southern Pennines.—Prof. J. K. Charlesworth: The South Wales End Moraine.
NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at Institution of Automobile Engineers, Watergate House, Adelphi), at 5.30.—Rhys Jenkins: A Chapter in the History of the Water Supply of London—A Thames-side Pumping Installation and Sir Edward Ford's Patent from Cromwell.
INSTITUTION OF AUTOMOBILE ENGINEERS (Manchester Centre) (at Engineers' Club, Manchester), at 7.—M. Platt: Safety in Four-Wheel Braking Systems.
ALCHEMISTS' SOCIETY (at Glasgow University), at 7.30.—Prof. H. E. Armstrong: The Future Alchemist.
ROYAL SOCIETY OF ARTS, at 8.—Sir Henry A. Miers: Museums and Education.
EUGENICS SOCIETY (at Royal Society), at 8.30.
HASLINGDEN AND DISTRICT TEXTILE SOCIETY (at Grammar School, Haslingden).—H. Bromiley: Processes from the Field to the Finished Yarn (Lecture).

THURSDAY, JANUARY 24.

ROYAL SOCIETY, at 4.30.—Dr. D. Denny Brown: (*a*) On the Nature of Postural Reflexes; (*b*) The Histological Features of Striped Muscle in Relation to its Functional Activity.—W. S. Stiles: The Effect of Glare on the Brightness Difference Threshold.—L. J. Harris: The Combination of Proteins, Amino-Acids, etc., with Acids and Alkalis. Part II. Titration Curves of Amino-Acids, in presence of Formol.—*Papers to be read in title only*:—Dr. F. W. R. Brambell and G. F. Marrian: Sex-reversal in a Pigeon (*Columba livia*).—Prof. J. B. Gatenby and Sylvia Wigoder: (*a*) The Effect of X-radiation on the Spermatogenesis of the Guinea Pig; (*b*) The Post-Nuclear Body in the Spermatogenesis of *Cavia corbaya* and other Animals.
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15—Gordon Home: Roman London (II.).
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—J. Wright and C. W. Marshall: The Construction of the Grid Transmission System in Great Britain.
INSTITUTION OF THE RUBBER INDUSTRY (Manchester and District Section) (at St. Mary's Parsonage, Manchester), at 7.—Dr. E. G. Ritchie. Storage of Steam.
ROYAL AERONAUTICAL SOCIETY (at St. Ermin's Hotel, Caxton Street), at 7.30.—Informal Discussion on The Compression Ignition Engine for Aircraft.
ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Sir William de Courcy Wheeler: Traumatic Rupture of the Urethra.

FRIDAY, JANUARY 25.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre—Dublin) (at Gaiety Theatre, Dublin), at 4.—Ll. B. Atkinson: How Electricity does Things (Faraday Lecture).
ASSOCIATION OF ECONOMIC BIOLOGISTS (Annual General Meeting) (in Botany Lecture Room, Imperial College of Science and Technology), at 5.—S. G. Tallents: The Work of the Empire Marketing Board.
PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Prof. C. V. Boys: A Fused Quartz Pendulum Rod for Clocks.—G. W. Sutton: A Method for the Determination of the Equivalent Resistance of Air-Condensers at High Frequencies.—L. Hartshorn: The Measurement of the Anode Circuit Impedances and Mutual Conductances of Thermionic Valves.
ROYAL SOCIETY OF MEDICINE (Children Section), at 5.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith. The Anatomy and Evolution of the Human Brain.
SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Engineers' Club, Birmingham), at 7.—Prof. W. E. S. Turner: Communications from the Department of Glass Technology, The University, Sheffield.
MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section), at 7.
INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. T. Usher: Bromoil.
WEST OF SCOTLAND IRON AND STEEL INSTITUTE (at Royal Technical College, Glasgow), at 7.—J. Mitchell: The Manufacture of Iron and Steel Tubes.
INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Students' Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.15.—S. Gibson: The City of Winnipeg Hydro-electric Power Station.
BLACKBURN TEXTILE SOCIETY (at Bradford Technical College), at 7.30.—W. Wilkinson: Power Loom Pickers and Picking (Lecture).
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—M. J. McCarthy: Notes on Winches, Derricks, and other Lifting Appliances used in Modern Building Construction.
ROYAL SOCIETY OF MEDICINE (Epidemiology Section), at 8.—Dr. Ledingham, Dr. G. F. Buchan, and others. Discussion on Vaccination Against Smallpox in the Light of Recent Experience.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. A. C. Seward. The Vegetation of Greenland.

SATURDAY, JANUARY 26.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. E. Cammaerts: Flemish and Belgian Art (II.). The Landscape.

PUBLIC LECTURES.

FRIDAY, JANUARY 18.

UNIVERSITY COLLEGE, at 5.—C. F. Pantin. Comparative Physiology. (Succeeding Lectures on Jan. 25, Feb. 1, 8, 15, 22, Mar. 1, 8, 15, and 22.)

SATURDAY, JANUARY 19.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—D. Martin Roberts. London through the Ages.

MONDAY, JANUARY 21.

EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—F. Rayns: The Cultivation of Sugar Beet.

WEDNESDAY, JANUARY 23.

IMPERIAL COLLEGE OF SCIENCE—ROYAL SCHOOL OF MINES, at 5.30.—Dr. A. McCance. Some Applications of Physical Chemistry to Steel Manufacture. (Succeeding Lectures on Jan 24, 30, and 31)

THURSDAY, JANUARY 24.

UNIVERSITY COLLEGE, at 5.—Dr. R. J. Ludford: Cytology in Relation to Physiological Processes. (Succeeding Lectures on Jan. 31, Feb. 7, 14, 21, and 28)
BEDFORD COLLEGE FOR WOMEN, at 5.15.—W. P. Yetts: Chinese Architecture.

SATURDAY, JANUARY 26.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. Harcourt. The Lure of India.

CONFERENCE.

SATURDAY, JANUARY 19.

JOHN INNES HORTICULTURAL INSTITUTION (Merton), at 2.30.—Conference on Polyploidy in Relation to Species and Horticultural Varieties.
Dr. C. C. Hurst: Polyploidy in the Genus *Rosa*.
Prof. R. R. Gates: The Origin of Polyploids.
J. B. S. Haldane: Laws of Inheritance in Polyploids.
Dr. C. D. Darlington: The Importance of Chromosome Behaviour in Polyploids.
Dr. C. L. Huskins. Polyploidy in Cereals.
M. B. Crane: Polyploidy in Strawberries, *Rubus* and *Prunus*.
Miss Caroline Pellew: *Primula Kewensis* and Species Hybrids.
Dr. F. W. Sansome. Polyploidy in Tomatoes.

NATURE

SATURDAY, JANUARY 26, 1929.

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Scientific Research and Tropical Development.

IN the three previous reports on the Colonies for which he was either wholly or partly responsible, Mr. Ormsby-Gore had perforce to deal at length with constitutional and political issues, questions of land tenure and other land problems, and labour problems. But the constitution of British Malaya is not at present a subject of controversy: the constitutional and political problems of Ceylon have been dealt with specifically by the Donoughmore Commission ; and the constitution of Java, a Dutch Colony, is obviously not a matter upon which a British Minister should be expected to express opinions. Apparently there are no difficult land or labour problems in British Malaya and Ceylon. Consequently, in his report on British Malaya, Ceylon, and Java (Cmd. 3235, H.M. Stationery Office, 1928 ; 4*s*. 6*d*.), Mr. Ormsby-Gore is able to deal exhaustively with the subject nearest to his heart, the application of science to those public services upon which the physical health and the wealth and intellectual progress of communities depend.

It must be confessed that in this report he shows himself far more critical of the attitude of local governments and non-official Europeans towards their problems than in any previous report. This can be attributed to the fact that he brings to bear upon these problems the knowledge and experience he has gained by his visits to other colonies, and the contacts he has made with scientific workers, educationists, and technicians throughout the whole Empire. During the past five years he has served on every government committee set up in Great Britain for the furtherance of education, public health, and scientific research in the Empire, and he has thrown himself whole-heartedly into the work. Probably no public man, certainly no Minister of the Crown, has ever had such opportunities for making himself personally acquainted with the tasks confronting workers in these three important fields of endeavour, and the workers themselves. Small wonder that his grasp of the essentials of tropical development has developed or that his critical faculty has been sharpened.

There is evidence that the white community, in Malaya at least, is not altogether satisfied with the results of Mr. Ormsby-Gore's visit. He has discovered too much and been too outspoken a critic to earn popularity. Business men in Malaya are probably like business men everywhere, inclined to attribute their successes to their own brains and

initiative and all their failures to the government; at one moment to cry aloud to the government for protection, at the next to curse the government for its interference; to beg for government assistance in their various enterprises, and then to criticise the government for its increased expenditure in satisfying their demands. We are only too familiar with these moods of 'business' men and farmers in post-War England. We know, too, how bitterly they resent being shaken from their complacent belief in their own super-efficiency by well-informed criticism, with what Micawberish optimistic obstinacy they wait upon events, trusting to luck, instead of courageous reorganisation to meet changing conditions, to bring back prosperity. But heirs to prosperity are notoriously blind to the facts of history. The European planters in British Malaya are no exception to rule They have acquiesced in the starvation of the research and technical services. In consequence they have lost several of the best officers of the Agricultural Department. They disregarded for fifteen years the advice of the Agricultural Department on the subject of soil erosion on rubber estates. They have disregarded the work being done by the Dutch in Java. The big rubber plantation companies are now seriously threatened by the native small-holder. Naturally, it must be galling to them to be told by Mr. Ormsby-Gore that

"The only justification for the present complicated and expensive mechanism of directors, agent firms, visiting agents, managers, and shareholders is the application of greater intelligence and skill than the native can reasonably be expected to acquire."

Lest this were not sufficient blow to their self-esteem, they are informed also:

"It is to the individual enterprise, industry, and thrift of the Chinese merchant and petty trader, the Chinese craftsman, the Chinese coolie, and above all the small Chinese contractor with his 'Kongsi' or guild, that the great wealth and development of British Malaya are mainly due."

It will be remembered that, when Great Britain was suffering from acute trade depression in 1921–22, the government appointed a commission under the chairmanship of Sir Eric Geddes to inquire into government expenditure with the view of effecting economies therein. Had that commission's recommendations been put into effect, practically the whole of the government's research and technical services would have been crippled, and a severe blow been administered to the education services of the country. British Malaya is now faced with trade depression owing to the fall in price of rubber and tin, its two chief economic commodities. If his opinion reflects that of the present government, Mr. Ormsby-Gore's comments on the situation indicate the distance and the direction in which his colleagues have travelled since 1922. He says:

". . . economies in the public services will no doubt have to be considered. On the other hand, there can be little doubt that further development and expansion depend very largely on an active and progressive policy on the part of the technical departments, such as agriculture, public health, education, forestry, veterinary, railways, and public works. The higher staffs of these services are recruited by the Secretary of State for the Colonies, and Malaya cannot afford other than the best men available."

He states further that

". . . the scientific services have not hitherto always received that recognition which can alone ensure an adequate supply of up-to-date technical officers possessed of that training and leadership which are required for modern development."

We are informed that the Malayan Agricultural Department at Kuala Lumpur has not been properly supported. At the present time, in spite of the signal proofs its officers have given of their capacity to improve the crops of the country, "its present accommodation in the way of offices is overcrowded and inadequate." The large field station initiated at Serdang in 1921 has no laboratories, the nearest being the Kuala Lumpur laboratory, seventeen miles away, which makes it difficult to maintain any close or continuous touch with it. Again, since there is no agricultural school in Malaya—in marked contrast to Java, which has an admirably co-ordinated system of agricultural education—"the liaison between the work of the Department and European or native agriculturists is still very imperfect. The Department has in fact worked in isolation under grave disadvantages and often neglect." There is now a Rubber Research Institute at Kuala Lumpur, but this was started only in 1925. Mr. Ormsby-Gore says he is convinced that "on research rather than restriction depends the prosperity of the rubber industry," but there are still many plantation companies which look to the government to fix prices on the basis of what the least efficient estates consider a reasonable level, and ignore scientific research. Animal industries in Malaya, due to the fact that there is no real veterinary department, are not being developed.

The agricultural situation in Ceylon is much more hopeful. "Public opinion in Ceylon is now very much alive to the need for furthering research in agriculture." At Peradeniya, there are the headquarters

of the Agricultural Department, the Botanic Gardens, a central experimental station, central laboratories and library, a farm school, and the head office of the Ceylon Rubber Research Institute. Agriculture now forms part of the curriculum of two of the voluntary secondary schools, each of which has its own farm, namely, Trinity College, Kandy, and Richmond College, Galle. 748 Government and 100 assisted schools have school gardens. There is a separate Tea Research Institute, financed by a cess on all tea exports, at present located in temporary quarters at Nuwara Eliya. There is also a separate Veterinary Department with a Central Laboratory at Colombo at which "some excellent research work has been done." The Government Dairy Farm in Colombo and the branch farm at Ambepusa, under the control of the Veterinary Department, provide facilities for breeding and feeding experiments.

"Ceylon," Mr. Ormsby-Gore reminds us, "is, after India, the largest tea-producing country in the world. It is the chief exporter of coconuts and coconut products in the Empire. It ranks third in the world as a producer of rubber. It is the principal producer in the world of cinnamon and citronella. It produces the highest grade and highest priced cocoa." Coffee was once an important crop, but this industry was practically wiped out by disease, particularly *Himeleia vastatrix*. In the opinion of experts, however, modern Java *robusta* coffees, highly resistant to disease, would do well in Ceylon and prove commercially profitable. The rice area could also be extended with advantage, particularly if more research were directed towards increased yields per acre. Mr. Ormsby-Gore also suggests that sisal might profitably be introduced into the dry zone and the natives be encouraged to grow tobacco as a rotation crop to sesame (locally known as 'gingelly').

While the Ceylon Agricultural Department is ahead of the corresponding service in British Malaya, the reverse aspect is presented by the respective forestry services. The Malayan Forestry Department is well staffed, it has achieved a uniform policy throughout the peninsula, and its research, experimental planting, conservation and commercial development sections, are all doing admirable work in accordance with a properly co-ordinated plan. It is true that British Malaya, in spite of the fact that four-fifths of the territory is under forest, still imports large quantities of timber from the neighbouring Dutch colonies, but it is hoped that it will not be long before it is entirely self-supporting in this respect. The need for a well-defined forestry policy with regulations directly enforced by the administration is emphasised by the fact that the Conservator of Forests estimates that 75,000,000 tons of timber in the most accessible areas have been wasted by the ruthless burning out of forests to make room for rubber plantations or to mine for tin.

As regards Ceylon, we are informed that there was no effective forestry control or policy until 1907. For generations before that the best and most valuable trees had been cut out indiscriminately. "The export of satinwood from Ceylon was very extensive in the early years of the nineteenth century, and little or nothing was done until quite recently in the way of conservation, regeneration, and improvement of forests by scientific clearing or planting. Even when the Forestry Department was first established (in 1907), the policy then adopted was wrong, uneconomic, and unscientific." Not until 1921 was any attempt made to rectify matters. In that year a report was made by a visiting forestry officer, after which a Commission was appointed to make an exhaustive inquiry. This Commission took five years to complete its work, and "*the putting into force of its many proposals is still under consideration.*" (Italics ours.)

The sections of Mr. Ormsby-Gore's report dealing with the public health services of the two British Colonies are informative, illuminating, and suggestive. In attaching the greatest importance to preventive as compared with curative medicine, he is following the best precepts of our time. "There is no part of the Empire where the progress of medical and sanitary science can be studied with greater advantage than in British Malaya," he informs us. For climatic and ecological reasons Malaya is naturally highly malarious, and "malaria is still the disease responsible for the highest mortality in both the Straits Settlements and those Federated Malay States where vital statistics of sufficient scientific value are obtainable." In addition to high mortality, "malaria is the main indirect cause of debility, suffering, and death from other causes." Again, the tropical peoples of Malaya, like those in other parts of the tropics, possess very little resistance to pneumonia and tuberculosis. As in other tropical countries also, helminthic and venereal diseases cause much debility and loss of efficiency among the peoples of Malaya. The venereal disease problem of Singapore is aggravated by the fact that Singapore city "is one of the main ports of the world visited by vessels of every flag from every country."

Mr. Ormsby-Gore pays tribute to the public

health authorities in British Malaya for the work which has been and is being done to cope with these many difficult problems. He also commends the public health work which has been undertaken by private enterprise on the part of rubber and mining companies, and the pioneer work of such private practitioners as Sir David Galloway and Sir Malcolm Watson. In particular, he says the anti-malarial work of the Malay States is rightly held up as an example among the countries of the world. Again, he states that the medical research services and the provision made for medical education are alike excellently conceived and efficiently carried on. It is in no spirit of carping criticism that he suggests the existing dichotomy in the public health services in Malaya should be ended, that every medical practitioner in a tropical climate should be a sanitarian, that the financial rewards available to the public health worker as compared with those obtainable in ordinary medical private practice should be reconsidered, and that more liberal leave should be given to the officers of the public health services of Malaya to enable them to take refresher courses at the London School of Hygiene and Tropical Medicine.

A different note is struck on the Ceylon public health services. Ceylon has the most extensive and expensive hospital system of any British possession, but " medical research, modern medical practice, public health services, and preventive medicine in Ceylon are not up to modern standards and are below the public need." It is Mr. Ormsby-Gore's impression " that in medical education and practice the community as well as a large section of the medical profession in Ceylon are still living in the nineteenth rather than the twentieth century." Accordingly, he throws out a series of important suggestions for consideration by the government and the public in Ceylon, in which he emphasises the need for a new central medical research institute, an overhaul of the medical education work, improved status and conditions of service for public health officers, and the teaching of personal and public hygiene in all schools.

We have dealt extensively but by no means exhaustively with this report by Mr. Ormsby-Gore. His views on other subjects connected with the economic development and intellectual progress of the peoples of the East Indies and Ceylon for whom Europeans have assumed responsiblity will repay the most careful study by all interested in the development of the British Empire, and in particular by those who wish to understand what science has done and still can do for our subject peoples. There is a certain unenviable forbidding notoriety attached to blue-books printed for the special edification of members of Parliament, which militates against their wide distribution among all classes of the population. This is unfortunate, because the reports of Mr. Ormsby-Gore are full of accurate information, presented in easily assimilable form, which would be invaluable to students in all our secondary schools. They are a liberal education in themselves, and free copies might with advantage be distributed by the Board of Education to all schools in the country. The expense would be negligible in comparison with the interest they would awaken. One thing is certain : all scientific workers with a regard for the profession to which they belong should take the first opportunity to make themselves acquainted with the contents of this last report on Malaya, Ceylon, and Java. They will not only find there a complete justification for themselves and their special studies, but also will be made more fully aware of their responsibilities to the world at large and their potentialities for good. In the Under-Secretary for the Colonies they have a firm friend and doughty and authoritative protagonist.

In congratulating Mr. Ormsby-Gore on his signal achievement, we are conscious of the debt of gratitude we owe to his labours on behalf of science.

British Folklore.

(1) *English Folklore*. By A. R. Wright. (Benn's Sixpenny Library, No. 33.) Pp. 80. (London: Ernest Benn, Ltd., 1928.) 6*d*.

(2) *Folklore of the British Isles*. By Eleanor Hull. (Methuen's Anthropological Series.) Pp. xii + 318. (London: Methuen and Co., Ltd., 1928.) 7*s*. 6*d*. net.

BOTH these books appeared opportunely. Their date of publication falling near the jubilee congress of the Folklore Society, they served to supplement the proceedings of that congress in demonstrating to the general public a broader conception of the aims and methods of the study of survivals. It is patent from incidental references and the occasional correspondence in the daily press that there is a widespread interest among the public in the vestiges of our popular custom and belief ; but there is little evidence of appreciation of the fact that these queer practices are worthy of serious study or that their collection or record has any object other than the satisfaction of a curiosity about the past. The collection of facts is indeed of paramount importance, especially

when the material is disappearing rapidly before the spread of education and the standardisation of culture which must ultimately obliterate local peculiarities; but it is not the exclusive end of the study, and unless the material acquired is surveyed periodically on broad lines in relation to the general problems of the science, there is a danger that it may cease to be regarded seriously and fail to attract the public interest and support without which in present conditions scientific research can scarcely maintain its full vigour and attract serious workers. At the recent Folklore Congress, conditions in England were contrasted with those on the Continent, where, it was pointed out, in various countries chairs in the study of the folk have been established, and it has been introduced into school curricula. But to secure even academic support a study must justify its existence.

Though this is not the occasion for a review of the methods of folklore studies during the last fifty years, it is necessary to emphasise the needs which Miss Hull and Mr. Wright have met in order that their work may be fully appreciated. To the achievements of their great predecessors, Frazer, Gomme, Hartland, Miss Burne, and all who assisted in the compilation of the "Handbook of Folklore," they would be the first to pay homage. But much that was implicit in the works of these writers has been made explicit and reviewed in the light of later knowledge; much that was intended for the needs of the student has been made accessible to a wider public. Though both Miss Hull and Mr. Wright confine themselves to a specific geographical area, the principles upon which their analysis proceeds are of general application.

(1) Mr. Wright's book will help to dispel any idea that few vestiges of popular belief and superstition, except on certain lines, remain in England. His little book is a remarkable feat of condensation, yet as it is, he has to express regret in a final chapter that he has been unable to deal with a number of subjects such as folk song and dance—the latter a fruitful subject—folk drama, proverbs and riddles, games, and folk art. Yet in seven chapters he has covered a multiplicity of subjects, such as birth, courtship, marriage, and death, business and work, calendar customs, ghosts and supernatural beings, divinations, charms, witchcraft, to name the most important; nor is his material obsolete or even mainly drawn from the records of the past. Nearly all his illustrative citations are of incidents which have occurred since the War. Of these, the cases of witchcraft may be familiar, as they receive more notice in the Press and tend to be remembered. One of the most remarkable was that at Newton Abbot in 1926 of a man who objected to his wife placing a ring of salt around his chair because she believed he had bewitched his son.

Mr. Wright is incorrect in placing the last ducking of a witch in Northamptonshire. The 'White Witch' who diagnosed the case came from Northamptonshire; the ducking took place in Hertfordshire. The victims lived at Tring. Although the panel of the Insurance Acts has done much to eradicate the popular pharmacopœia, the help of the white witch is still invoked. Mr. Wright records a charm for toothache which involves the insertion of human hair in a slit in the bark of an ash tree. It may be mentioned that American negroes also do this. The point is of interest, as much of the negro belief in the United States is European and not African in origin. Even the Voodoo cult is of European origin, in name certainly, and possibly to some extent in practice.

(2) Miss Hull's book differs from that of Mr. Wright in both scope and method. The latter lays down principles which are illustrated by examples of English folklore. Miss Hull aims at giving an account, as complete as her space allows, of the various phases and aspects of belief and custom in the whole of Britain from the earliest times of which there is any record susceptible of interpretation. For by inference we may probe even so far as the Stone Age, and legend and story take us back with certainty to the Iron Age. Both Mr. Wright and Miss Hull point out that Britain, having been overrun by people after people, its folklore is a series of superpositions of different racial beliefs. Yet it is remarkable how little can be identified as distinctively Saxon, while legendary lore is almost exclusively Celtic. Was this due to the fact that, while the Saxon conquerors were able to establish their institutions, their beliefs had no opportunity to become ingrained in the general mass of the population before they were overwhelmed or transformed by Christianity? Or was the general run of folk belief, apart from the pantheon, so closely akin as to escape subsequent discrimination? And when the Normans came, was a feudal practice imposed upon a ritual which had continued through Saxon from British times? Such, for example, would be the origin of the popular court held annually in some localities under an ash or other tree by the roadside and the 'gospel oak' as a boundary mark. So also the feudal due of a buck and doe offered at St. Paul's in London at the two feasts of St. Paul, for which

Miss Hull offers an explanation, which, by the way, was also suggested in our Calendar of Customs and Festivals (see NATURE, Jan. 21, 1928, p. 121).

So far as Britain is concerned, the cult of the horse may be peculiarly associated with the Saxons. There are references to it in the chronicles additional to the evidence of archæological relics. Miss Hull does not deal with the horse under 'animal cults,' but in connexion with one Irish practice, allows herself to accept, though apparently without strong conviction, the hard-worked explanation of totemism. The kings of Cenel Conaill, Western Ulster, were consecrated by the ceremonial slaying of a white mare, in the broth of which the chieftain bathed, while his people solemnly partook of its flesh in a feast. This certainly has all the appearance of an admission to a clan totem group and a ritual feast. If it is so, this takes us back to a very primitive phase of Nordic belief, possibly before the cult of the horse had become even tribal. But in India, where the horse is sacrificed by Aryan peoples, the rani must perform a certain rite with the sacrificed animal, which indicates either that it is identified with the rajah or is regarded as possessing marital rights over the women of the social group, that is, the act is an assertion of the divine individuality of the group, analogous to the assimilation of the Irish king to the divine identity of the group over which he is to rule.

Miss Hull has dealt fully with most sides of British belief—well worship, tree worship, stone worship, worship of the sun and moon, animal cults, sacrifice, and so forth. Her chapters on calendar customs are selective but illuminating. Most of all, however, we are indebted to her for her systematic handling of the Irish material, of which her profound knowledge has enabled her to introduce order where it was badly needed, and at the same time to make known to a wider public in assimilable form much that is of profound interest in the history of the British Isles.

The Properties of Silica.

The Properties of Silica: an Introduction to the Properties of Substances in the Solid Non-conducting State. By Dr. Robert B. Sosman. (American Chemical Society Monograph Series, No. 37.) Pp. 856. (New York: The Chemical Catalog Co., Inc., 1927.) 12.50 dollars net.

IT is unusual to write a whole volume about a single oxide of one of the elements; but if any oxide deserves this place of honour, it is certainly silica, since no other compound possesses such an array of interesting physical properties, even if we leave out of account all its chemical reactions. A precedent for monographs of this type has been set by Le Chatelier's books on "Le Carbone" and "La Silice," and it is not a mere coincidence that the *doyen* of French chemistry should have selected silica as the subject of his second series of published lectures. Le Chatelier's book, however, is of quite a different character, since it preserves the narrative form of the lectures, and tells a simple story in simple words. Dr. Sosman's book, on the other hand, is essentially a reference-book, in which *all* the information about the physical properties of the various forms of silica is catalogued and reviewed.

The book is made more formidable by the author's anxiety to use a logical method of classifying data, since he threatens in his introductory chapter to write a book of fifty-seven chapters, in order to deal with all possible combinations of the six fundamental concepts of length, time, mass, electric charge, entropy, and energy; and in discussing the micro-forms of quartz he insists that they may be 'micro' in one, two, or three dimensions (flaky, fibrous, or granular), and that these micro-forms may be crystalline, amorphous, or aphanitic, so that nine classes are possible. In these circumstances it is perhaps fortunate that the number of fundamental concepts is six and not twelve, and that the micro-forms are not classified into triple groups according to a third or fourth property, so as to increase the nine classes to eighty-one. In the opinion of the reviewer, schemes of classification such as this should be concealed, like the working-parts of a British locomotive, instead of being displayed ostentatiously like the working-parts of some American and Continental engines. In the present instance the author's determination to make his treatise complete, by including definitions of entropy, crushing strength, index of refraction and optical rotatory power, as well as tables showing the nomenclature of the thirty-two classes of crystal symmetry and the classification of radiation over the range from γ-rays to Hertzian waves, has led to the production of a volume of 856 pages, which is priced at 50s., and will therefore be purchased for the most part only by specialists and by reference libraries.

As a reference book, however, this monograph is admirable, since it covers all the physical properties of silica in all its various forms. Since quartz, tridymite, and crystobalite exist in two, two, and three forms respectively, there are eight distinct crystalline forms to be considered in addition to the

amorphous varieties. The interconversion of these eight forms gives scope for the author's fondness for classification, although nothing at all is known about some of the possible transformations. The 'high-low' transformations of quartz, tridymite, and crystobalite are, however, totally different from those of the three main forms, since they do not proceed from nuclei or centres, but take place completely, reversibly, and almost instantaneously throughout the crystal when the inversion temperature is reached, so that it has actually been proposed to use one of them as a secondary standard in thermometry. The same type of transformation is seen in the $\alpha\ \beta$ change in iron, but we have not yet reached a stage at which the two kinds of polymorphism can be discussed conveniently in elementary books on physical chemistry, since the underlying changes of structure are still open to discussion.

From this point of view, X-ray analysis is proving to be of fundamental importance; but in the case of quartz the progress hitherto made has not been sufficient to establish once for all an undisputed orientation of the atoms of silicon and oxygen, and the story which the author has to tell is therefore a long one instead of a short one. Thus the chapter on "The Ultimate Structure of Silica" is followed by a chapter on "The Hypothetical Structure of Low-Quartz," in which the views of McKeehan, W. H. and W. L. Bragg, Gibbs, Beckenkamp, Sohncke, Huggins, and Ichikawa are cited. In the opinion of the reviewer, the key to the problem of the structure of crystalline silica is to be found in a recent paper by Prof. F. S. Kipping on "The Carbon-silicon Binding" (*Trans. Chem. Soc.*, p. 104; 1927) in which he writes:

"Fresh evidence is continually being obtained by the author that an ethylenic binding between carbon and silica is either impossible or can only be produced under exceptional conditions. Those reactions which lead to the formation of an olefine seem to be quite inapplicable to the production of the group $>Si:C<$."

This observation provides an excellent illustration of G. N. Lewis's view, that the formation of double bonds is different or impossible except between elements of the first short period. If, then, we admit that silicon is unable to form a double bond, it follows at once that a molecule of silica must have an unsaturated structure, and in particular that each molecule of silica has four spare bonds just like an atom of carbon, thus:

$$—O—\overset{|}{\underset{|}{Si}}—O— \text{ ; compare } —\overset{|}{\underset{|}{C}}—$$

The rise of boiling-point from $-80°$ to $+2600°$ on passing from CO_2 to SiO_2 can then be attributed to the same cause as the rise of boiling-point from $-196°$ to (say) $+3800°$, on passing from nitrogen to carbon, namely, the transition from a saturated molecule, $O=C=O$ or $N \equiv N$ to an unsaturated system, as formulated above.

The discussions of the structure of the various forms of quartz are followed by sections dealing with the thermal and mechanical properties, the piezo-electric and pyro-electric properties, and finally the optical properties under the heading "Silica in the Periodic Electromagnetic Field." The data collected in these sections are so numerous that one can only assume that the collection is complete; and the reviewer is certainly not in a position to point to any gaps, apart from the lag that is inevitable when dealing with a subject that still plays an active part in current literature.

The final section of the book deals with applications, and includes seven chapters, describing silica minerals and rocks, vitreous silica and silica refractories, the geological and industrial applications, and the chemical and physical uses of silica. The whole volume is a monumental work which may be consulted with advantage by all those who want to know anything about silica but may not have access to the original literature; and even those who are seeking first-hand information will find in it a trustworthy guide to the papers which they ought to read, and an excellent summary of their contents. The only complaint that can be made is in reference to the possibility of having 'too much of a good thing,' since the elementary student might well be frightened if there were any prospect that all the chemical compounds of all the elements might be monographed in the same efficient way.

T. M. LOWRY.

Regional Geography of Great Britain.

Great Britain: Essays in Regional Geography. By Twenty-six Authors. Edited by Alan G. Ogilvie. Published on the Occasion of the Twelfth International Geographical Congress at Cambridge. Pp. xxx + 486. (Cambridge: At the University Press, 1928.) 21*s*. net.

THE origin of this book is probably to be found in a conversation which the editor, Mr. A. G. Ogilvie, had with a well-known French geographer some two or three years ago. Mr. Ogilvie in his preface points out that there is a certain lack of modern authoritative geographical works dealing with Great Britain, and remarks that, although there are now twenty-one departments of geography

in universities and university colleges in Great Britain, no attempt had been made, until this book was planned, to gather together the accumulated experience of the heads of these departments and the results of their studies in their own regions. He therefore made the suggestion to the British National Committee for Geography, a body which was formed on the initiative of the Royal Society, and is one of the constituent members of the International Geographical Union, that a composite volume should be published, to be written in the main by the heads of departments of geography, and that this volume should contain accounts of the geography of the various regions of the country by those who had specially studied them.

This suggestion was approved by the National Committee, especially as it was accompanied by the proposal that the volume should be presented free to the foreign geographers attending the International Geographical Congress of July 1928. The National Committee formed a special committee to arrange for the production of the book.

A general introduction is written by Sir John Russell, who, in the opening sentence, defines regional geography as the description of the regions of a country as they are and the discovery of the causes that have made them what they are; such a description would, no doubt, be taken to include the effect of the study of environment on the human generations that inhabit, or used to inhabit, the region. Sir John Russell speaks authoritatively of the agriculture and soils of the country. At the end of his introduction he mentions a fact of much interest to the student of population questions, namely, the curious change that is coming over the Clyde area, in which "a large foreign population, chiefly Irish, is taking possession, ousting the Scotsmen, and doing by peaceful penetration what no previous invaders were able to do by force." The same process is commented upon by Mr. Ogilvie at the end of his excellent account of central Scotland. He remarks that there is evidence that the Irish in Scotland will increase while the Scottish race decreases, and that, unfortunately, many of the cream of the Scottish people are emigrating every year. This "penetration of Protestant Scotland is viewed with alarm by many of her people, not so much on account of religious prejudice, as because of the social implications. Scotsmen value above all their nationality and traditions." The movement of population thus indicated deserves the attention of all geographers.

Dr. H. R. Mill contributes an admirably clear article on the climate of Great Britain, and following this article of eighteen pages we come to the series of twenty-three regional studies written by such authorities as Prof. Fleure, who describes Wales; Prof. Rishbeth, who deals with central south England; Mr. Jervis, the Severn Basin; Dr. Fawcett, the Pennines; Mr. Fagg, the south-east of England; Prof. Roxby, East Anglia; Mr. Debenham, the Fenlands; Dr. Rudmose Brown, the South Yorkshire Coalfield; Mr. A. Stevens, the Highlands and Hebrides; and a dozen other authorities, each writing with knowledge of the region dealt with.

The writers were given a very free hand in describing the various areas, but there is, as a fact, a kind of general similarity of treatment. In almost every case the regional study begins with an account, necessarily very brief, of the geology; then we usually find some description of the land forms and drainage system, followed by a note as to the climate, and, in some cases, an account of the vegetation. Then we arrive at the human side of geography, early settlement, changes in population, the character of the existing people, and agriculture and industry. Added to these, which we may perhaps describe as the orthodox mixture, we shall find miscellaneous comments on such subjects as the future of certain of the great centres of population; the significance of certain town sites; regional planning; the distribution of population, and, of course, the study of human geography; the effect of place conditions on the human race is, indeed, the principal reason for the existence of the subject of geography at all, apart from the necessary work of exploring and mapping the earth's surface.

The book is, from the nature of the case, condensed and 'facty.' It must be taken in small doses; but so taken, the reader will find in it much of interest, and much that he probably did not know before. One can obtain from it a good idea of the main conditions of human existence in the various characteristic divisions of Great Britain. It is a book that everyone either learning or teaching the geography of Great Britain should possess. It is well illustrated by figures and diagrams in black; but it will probably be found useful to study it with the additional aid of a quarter-inch map of the region which is being studied at the time. It should also be said that the book admirably fulfils its original purpose, namely, to present to the foreign geographers attending the International Geographical Congress "a synopsis by British geographers of the regional geography of Great Britain."

Our Bookshelf.

Fever, Heat Regulation, Climate and the Thyroid-Adrenal Apparatus. By Dr. W. Cramer. Pp. ix + 153 + 40 plates. (London: Longmans, Green and Co., Ltd., 1928.) 15*s.* net.

In this interesting little volume the author adduces evidence in favour of his view that heat regulation in warm-blooded animals is mainly under the control of the sympathetic nervous system, and that since the adrenal and thyroid glands are controlled by this system, the mechanism involved is both nervous and humoral. The activities of the two glands have been followed by the histological method: in the adrenal, fixation by means of osmic acid vapour discloses the presence in the resting medullary cell of fine black granules, which, from their absence from other cells and from their disappearance under conditions known to result in a secretion of adrenalin, are considered to indicate the presence of the base. In the case of the thyroid, conclusions are drawn from the appearance of the colloid and cells lining the alveoli. The numerous illustrations of drawings of actual microscopic sections show clearly the marked differences observable in the gland picture following exposure of the animal to heat or cold or injection of various compounds.

An essential part of the author's thesis is the consideration of the glycogen in the liver as a secretion rather than as a simple store of surplus carbohydrate; the presence or absence of glycogen is not a measure of the activity of the glycogenic function, since the amount present depends solely on the balance between production and secretion from the cell; increased glycogen means hyperactivity of the liver on the storage, inactivity on the secretory conception.

In general, the author throws a new light on, or gives a new interpretation of, established facts, and thereby clarifies several problems; in one or two cases, however, the foundations of the thesis appear insecure, owing to the experiments on which he relies being unconfirmed or not generally accepted; as an example may be mentioned the question of the influence of the sympathetic nervous system upon the metabolism of skeletal muscle. In his concluding chapters the author considers the relationships of climate and various pathological conditions to the heat-regulating mechanism. This is a most stimulating book, and should be read by all physicians, pathologists, and psychologists.

Allgemeine Biologie: eine Einführung in die Lehre vom Leben. Von Dr. Max Hartmann. Zweiter Teil: *Formwechsel und Reizerscheinungen.* Pp. v + 263-756 + ix. (Jena: Gustav Fischer, 1927.) 25 gold marks.

While some of the material in this book is years out-of-date, there are so many beautiful figures and descriptions from the works of the last generation of Continental zoologists, that the book will prove a very valuable addition to the library of the teaching zoologist. Some of the work of Bělař especially, which is incorporated, is extremely fine. The protozoological and cytological treatment is naturally very well done, if, as the reviewer has mentioned, a little behind the times. It is possibly somewhat tiresome to have served up to one the descriptive cytology and protozoology of the Bouin's fluid and Schaudinn's fluid epoch. The author would have done well if before finishing he could have read Wilson's "The Cell," but it would be cavalier to expect in a book of this size a treatment of various cytological subjects on the masterly lines of Wilson. There is a quite fine chapter on developmental physiology, written, as indeed is the rest of the book, concisely and clearly. The reviewer recommends teachers of zoology to obtain a copy of this work, because, in the absence of a good library, it will provide something from the work of the Continental protozoologists and cytologists. The author is to be congratulated on the manner in which he has brought forward a great mass of material, and condensed it into a splendid work of seven hundred pages.

J. Brontë Gatenby.

Man a Machine: in Answer to a Romantical and Unscientific Treatise written by Sig. Eugenio Rignano and entitled "Man not a Machine." By Joseph Needham. (Psyche Miniatures, General Series, No. 12.) Pp. 111. (London: Kegan Paul and Co., Ltd., 1927.) 2*s.* 6*d.* net.

The author has revived the title of a discourse which appeared in 1748 under the authorship of M. de la Mettrie, a Paris physician, who interpreted the nature of life on a basis of experiment and scientific observation. So materialistic a view was bound to call forth many replies—for example, "Man More than a Machine," of unknown authorship, in 1750—most of which were based on anti-materialistic ideas, more especially relating to the soul.

The controversy between the materialism of natural philosophy and the vitalism of the metaphysicians continues to experience periodic waves of revival; and again, in 1926, there appeared in this series of miniatures a philosophic presentation of Rignano's interpretation of life under the resuscitated title of "Man not a Machine." The booklet now under review is a reply to Rignano, in which the author presents scientific data, chiefly of a physico-chemical and embryological character, as being more directly related to his own work. Readers interested in a rational interpretation of living processes will find here some of the points at which the gradual encroachment of scientific method is continuously making inroads into the sacred preserves of vitalism.

The Earth: its Nature and History. By Dr. Edward Greenly. (The Forum Series.) Pp. ix + 54. (London: Watts and Co., 1927.) 1*s.* net.

The publishers of the Forum Series are gradually building up a library of cheap books of which they may well be proud. Prof. Julian Huxley and Sir Arthur Keith are among the earlier contributors, and now comes Dr. Edward Greenly with a fascinating

little volume on geology. In so far as it is possible profitably to discuss the make-up of the earth and its long history of changing landscape, climate, and life in 54 pages, Dr. Greenly has succeeded where most of his competitors have failed. His reputation as a brilliant but cautious geologist is so high that no one need doubt his authority to act as a guide to the beginner in a subject which is notoriously difficult to condense effectively. The book is beautifully written—obviously it was a pleasure to write it—and is everywhere clear and concise. It is imbued throughout with a mellow spirit of philosophy which will give pleasure to the professional geologist as well as to the general reader for whom it is intended. No better school introduction to geology could be wished for. So many small books of this kind are written by earnest amateurs who are generally ill-equipped for the difficult task of writing simplified geology, that it is a pleasure to find one by a master of his subject that can be cordially recommended.

Geology and Natural Resources of Colorado. By Prof. Russell D. George. (University of Colorado Semicentennial Series, 1877–1927, Vol. 1.) Pp. xv + 228. (Boulder, Colo.: University of Colorado, 1927.) 2 dollars.

THE professor of geology in the University of Colorado has attempted to summarise a vast subject in a small volume with results that are likely to be of greater value to the geographer than the geologist. Beginning with an elementary but well-illustrated introduction to geology and mineralogy, the succeeding chapters deal with the geological history of Colorado; the metallic ores; fuels; structural materials; water supplies; soils and agriculture; climate and scenery. The treatment is generally too sketchy to have any detailed value. We learn, for example, that "the region is one of profound folding and faulting, and intrusion of igneous rocks. In many places it is evident that there were at least two periods of folding and two or more periods of faulting. The igneous intrusions are also of different ages." This information cannot be said to be helpful.

The addition of a bibliography would have made the book really useful to geologists, and it is no excuse to say, as the author does in his preface, that "a worth-while bibliography . . . would be too voluminous." As it is, the book is likely to be appreciated only by teachers of geography in North America as a source-book. For that purpose it is well arranged and illustrated.

Leçons sur quelques équations fonctionnelles avec des applications à divers problèmes d'analyse et de physique mathématique. Par Prof. Émile Picard. Rédigées par Eugène Blanc. (Cahiers scientifiques, publiés sous la direction de Gaston Julia, Fascicule 3.) Pp. v + 187. (Paris: Gauthier-Villars et Cie, 1928.) 40 francs.

THE book under notice constitutes a valuable addition to the scanty literature of the calculus of functions, so called by de Morgan. Chap. i. deals with the functional equations forming the basis of proofs of the parallelogram of forces, with extensions to non-Euclidean statics, trigonometry and geometry. Chap. ii. treats of the functional equations expressing rational addition and multiplication theorems of uniform functions, with applications to elliptic functions and to Poincaré's transcendents. Chap. iii. deals with the canonical difference equation of the first order, with applications to doubly periodic functions of the first and second kinds and to Picard's transcendents. The last chapter brings a discussion of the functional equations of Abel and of Schröder, and concludes with an application of Fredholm's equation to the problem of Dirichlet for the potential of C. Neumann. As might be expected from such a master of his craft, M. Picard has treated a variety of difficult problems in a most elegant and stimulating manner, thus demonstrating the great power of methods based on functional equations, and his book can be highly recommended to all interested in this subject.

Calculations in Physical Chemistry. By Prof. J. R. Partington and S. K. Tweedy. Pp. viii + 152. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1928.) 7*s.* 6*d.* net.

THE problems selected by the authors are of the standard required for a degree in honours, and are based from the beginning on the use of the calculus. The six sections of the book deal with thermodynamics, characteristic equations, liquids and solutions, equilibrium, electrochemistry, and the heat theorem. Explanatory introductions are supplied to each section, and the answers to the problems are given at the end of the book. There is also a series of 100 miscellaneous exercises to which no answers are given. The book should prove of real value to those who wish to acquire a mastery of physical chemistry in its numerical aspects, and, in spite of its small size, the price is not excessive in view of the compact character of the contents.

Soil Management. By Prof. Firman E. Bear. (The Wiley Agricultural Series.) Second edition, thoroughly revised and enlarged. Pp. v + 412. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1927.) 17*s.* 6*d.* net.

THIS volume is primarily intended as a book for students, not only for those in college, but also for others who desire to gain an insight into modern methods of dealing with the various problems of soil management. Its general usefulness is testified to by the fact that a second edition is called for after three years. The requirements of crops and the characteristics of soils are outlined at the start, but the bulk of the work is devoted to a consideration of soil resources from the aspect of utilisation and conservation, together with the best methods of supplementing the natural supplies by fertilisers. Selected references bearing closely on the text are provided, together with a certain number of illustrations and diagrams.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Fluorescence of Mercury Vapour under Low Excitation.

IN earlier letters to NATURE (Aug. 18 and Nov. 10, 1928), I have described mercury fluorescence with exciting wave-length as long as λ3125. Since then even longer waves have been used. The source was a nickel arc, with a filter of natural (ortho) salicylic acid, which cuts off completely all waves shorter than 3360. The mercury vapour was at high density. The spectrum observed consists of the two well-known broad continuous maxima, one in the visual region (green fluorescence), and the other in the ultra-violet, from about 3130 to 3650. The latter has never, so to speak, been dissected. If it has appeared at all in any spectrum it has appeared complete, and it has never shown any signs of resolution into a fine structure.

It was of interest to see what would happen in the present case when excitation is applied near the middle of this band. The result is that it still apparently resists dismemberment, even in these trying circumstances: the whole of it is excited with a striking violation of Stokes's law. The continuous fluorescent spectrum extends as much as 300 A. beyond the limit of the exciting spectrum, as set by the sharp cut of the filter. Owing to stray light from the source, the fluorescent spectrum is only seen quite detached beyond this limit, and it is hard to say whether any discontinuity of intensity sets in at the beginning of the 'anti-Stokes' region.

RAYLEIGH.

Terling Place,
Chelmsford, Jan. 10.

Light-scattering and the Hydrogen Spectrum.

IN an important paper in the *Proceedings of the Royal Society* for January, Raman and Krishnan give an account of their researches on the production of new radiations by light-scattering. In 1928 they announced the discovery that when a transparent medium is irradiated by monochromatic light the radiations scattered by the molecules contain spectral lines of modified frequencies. The *difference* between the incident and the scattered frequencies corresponds to a characteristic infra-red frequency of the molecule. Such new lines are clearly shown in the beautiful spectrograms which illustrate their paper. The authors direct attention to the usefulness of this phenomenon as a substitute for infra-red spectroscopy.

The secondary spectrum of hydrogen contains many thousands of lines, of which only a small proportion has been classified. I wish to suggest the view that many of these lines arise in the way described by Raman and Krishnan, in conformity with the theoretical work of Smekal and others. When hydrogen gas is subjected to an electric discharge, the lines of the Balmer series are emitted by atoms of hydrogen, and the neighbouring molecules of gas must be subjected to bombardment by light quanta of corresponding frequency. Hence we should expect *each* Balmer line to be accompanied by a system of fainter lines, corresponding to molecular frequencies in the infra-red. The accompanying table shows some of the first results of an examination of the secondary spectrum in the neighbourhood of the five Balmer lines H_α to H_ϵ. The wave-numbers of these lines are given at the top of the table. In the lower part of the table are the wave-numbers and intensities of certain lines recorded by Gale, Monk, and Lee. The numbers in bold type are differences between such wave-numbers and the wave-number of the nearest Balmer line.

H_α	H_β	H_γ	H_δ	H_ϵ
15233·22	20564·79	23032·54	24373·06	25181·34
15102·10 (1)	20436·09 (1)	22903·51 (0)	24242·95 (1)	..
131·12	**128·70**	**129·03**	**130·11**	..
14970·53 (2)	20302·96 (3)	22770·26 (0)	24111·46 (2)	24919·57 (0)
262·69	**261·83**	**262·28**	**261·60**	**261·74**
14842·77 (oa)	20174·02 (1)	22643·75 (3)	23982·31 (2)	24790·49 (0)
390·45	**390·77**	**388·79**	**390·75**	**390·85**
14709·75 (oo)	..	22509·10 (2)	..	24657·74 (0)
523·47	..	**523·44**	..	**523·60**

It will be seen that these differences are approximately constant in each horizontal row, and are not far from the series of numbers 130, 260, 390, 520. In pure rotation spectra in the far infra-red the bands consist of a series of equidistant lines at intervals of $h/4\pi^2Ic$, where I is the moment of inertia of the molecule. Assuming that the lines represent a rotation spectrum, the B constant of the spectrum, which is defined by $h/8\pi^2Ic$, would be roughly equal to 65 cm.$^{-1}$. My fellow worker, Ian Sandeman, who discussed the Fulcher bands of hydrogen at the Royal Society of Edinburgh on Jan. 7, finds $B'' = 33{\cdot}39$ for this system, a value only one-half the above. This led me to search for intermediate lines in the rotation spectrum, resulting in the discovery of most of the remaining members. The first member, however, instead of appearing at 65 cm.$^{-1}$, is displaced and is found at 70 cm.$^{-1}$. It should be mentioned that in many cases lines are observed having a frequency *exceeding* the frequency of the exciting line by the appropriate infra-red frequency.

There are indications that in addition to the pure rotation spectrum described, there are lines due to vibration-rotation spectra. These are at present being investigated. The claim made by Raman and Krishnan that light-scattering serves as a powerful, convenient, and accurate method of exploring molecular spectra seems to be fully justified. It appears probable that it will be of the greatest service in disentangling the complex structure of the 'many-lined' spectrum of hydrogen.

H. S. ALLEN.

The University,
St. Andrews, Jan. 10.

Variation of Latitude with the Moon's Position.

RECENT investigations at this laboratory have suggested a possible connexion between the variation in latitude of a given place on the earth's surface and the position of the moon in the sky at the time observations for latitude are made. An analysis of the whole series of the latitude observations which were made by Ross at Gaithersburg from 1911 to 1914, has revealed a striking correlation between the moon's hour angle and the value of the latitude obtained. The data were restricted to results obtained with the photographic zenith telescope, thus eliminating all personal equation. For convenience the observations were divided into two periods, one from 1911 to 1913, the other from 1913 to 1914. According to Ross's estimates, the 1913 to 1914 observations were considerably superior to those of the earlier years, as is evidenced by the smaller probable error.

In conducting the analysis a card catalogue was made of the results of the observations of latitude for each night and each group of stars. The mean right ascensions of the group give the necessary data for ascertaining the moon's hour angle at the time of

observation. From the mean curve of latitude variation at Gaithersburg, extending over the period 1911 to 1914 and published by Ross, corrections were obtained to reduce each night's data to the mean latitude of Gaithersburg, determined from the observations of the whole period. The resultant values of latitude were then tabulated against the mean value of the moon's hour angle for each group of stars, and the

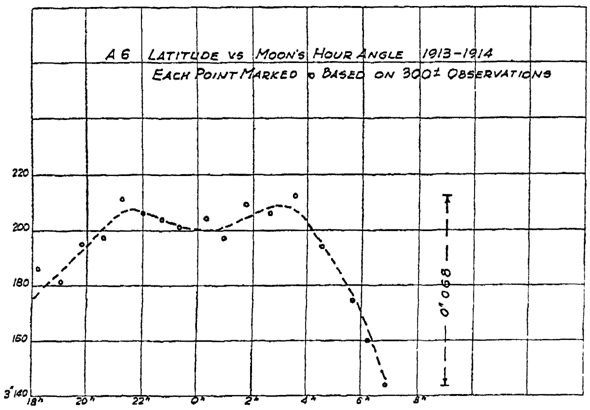

FIG. 1.

running mean, taking three at a time, gave the results graphically shown in Fig. 1.

Since the declination of the moon, and hence the observer's distance from the sub-lunar point, may vary greatly even for the same values of the hour angles, the hour angle and declination were transformed into altitudes and bearings by suitable tables. Again, the observations were divided into two series, one including those made when the moon was above the horizon, and the other when it was below the horizon.

The striking rise in the value of the latitude with the increasing altitude of the moon is shown strikingly in the altitude–latitude curve, Fig. 2, which again was plotted from the running means. The maximum latitude occurs at altitude 30°, or when the observer was 60° from the sub-lunar point. It should be stated that the extreme range of variation of latitude due

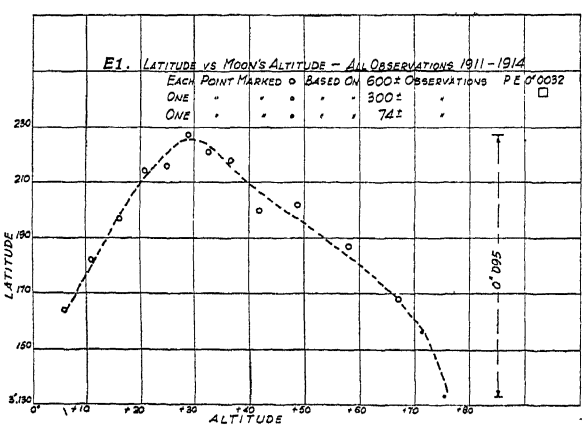

FIG. 2.

to this lunar effect was 0·08″ for the 1913–1914 series and about 0·09″ for the whole series 1911–1914. On account of the relatively greater degree of precision obtained in the 1913–14 series and the larger number of observations included, double weight was given this series in plotting the final graph as exhibited in Fig. 2. The fact that the total variation is about twenty times the probable error for each point on the curves leaves little ground for interpreting the curve as a chance phenomenon. The curve of observations for the moon below the horizon is radically different. A marked fall in the value of latitude follows the negative altitude of 30°.

In seeking an explanation for this extraordinary relationship, one is at a loss to account for the fluctuation on the grounds of any deflection of the vertical due to a theoretical tide in the earth's crust.

Meteorological causes, unless a function of the lunar hour angle, should have been practically eliminated in the averaging of between two and three thousand observations. The possibility, however, of the effect of an atmospheric tide may need some consideration. It should be noted that a change in refraction systematically introduced by the passing of an atmospheric tide is of the correct sign for the observed effect, but the magnitude of the variation seems too large to be accounted for on such a hypothesis.

One is led to interpret the result as a change in the

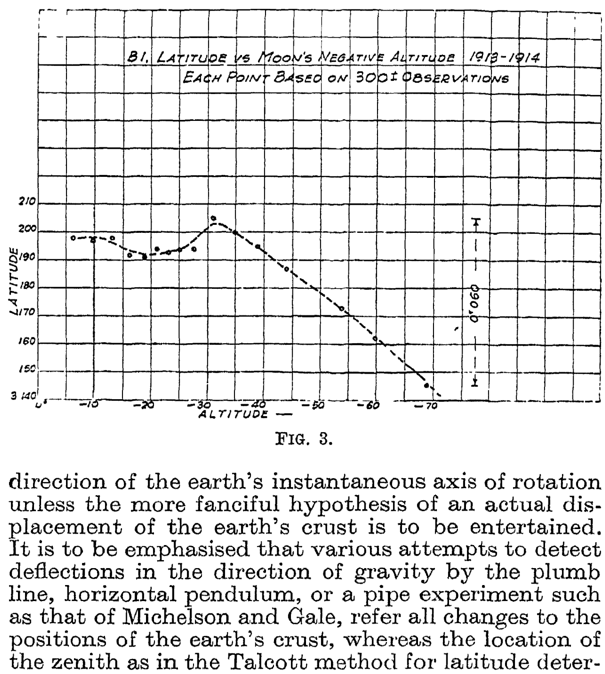

FIG. 3.

direction of the earth's instantaneous axis of rotation unless the more fanciful hypothesis of an actual displacement of the earth's crust is to be entertained. It is to be emphasised that various attempts to detect deflections in the direction of gravity by the plumb line, horizontal pendulum, or a pipe experiment such as that of Michelson and Gale, refer all changes to the positions of the earth's crust, whereas the location of the zenith as in the Talcott method for latitude determination refers the vertical to the direction of the earth's axis in space.

Whatever may be the causes involved, the importance of the consequences of such an observed effect scarcely needs to be emphasised, as it vitally concerns the fundamental determination of star positions. It is suggested that a possible explanation of the notable discrepancies in stellar co-ordinates from star catalogues of widely distributed observatories may, at least in part, be traceable to this lunar effect.

The investigation is now being continued in an analysis of the latitude observations made with the same instrument after its removal to the Naval Observatory at Washington. This latter investigation has now so far progressed as completely to confirm the correlation of the change in latitude with the lunar hour angle discovered in the Gaithersburg series of observations. In the preparation of the data for the analysis I have had the invaluable assistance of Miss Margaret Olmsted.

HARLAN TRUE STETSON.
Astronomical Laboratory,
Harvard University, Cambridge, Mass.

Structure of Pearls.

THE origin of pearls has been a subject of speculation of both laymen and men of science alike. In the literature on this subject, one finds that most of the scientific work has been done on pearls of commercial value, such as those from *Margaritifera vulgaris*, *M. margaritifera*, and *Mytilus edulis*, and that those from other molluscs, like *Pinna*, have been studied only by a few workers. Réaumur (*Mémoires de l'Académie des Sciences*; 1717) stated that shell extrusions were the causes of pearl formations in *Pinna*. Raphaël Dubois (*Annales de l'Université de Lyon*, Fasc. 29; 1909) on *Pinna* pearls states, "Je n'ai jusqu'à présent jamais rencontré dans le noyau des perles de *Pinna* rien qui ressemblât à un Distome ou à un Ver quelconque. Mais, dans deux exemplaires, dont un est né dans le parc du laboratoire, j'ai vu très nettement de petits corpuscles ovoides, de

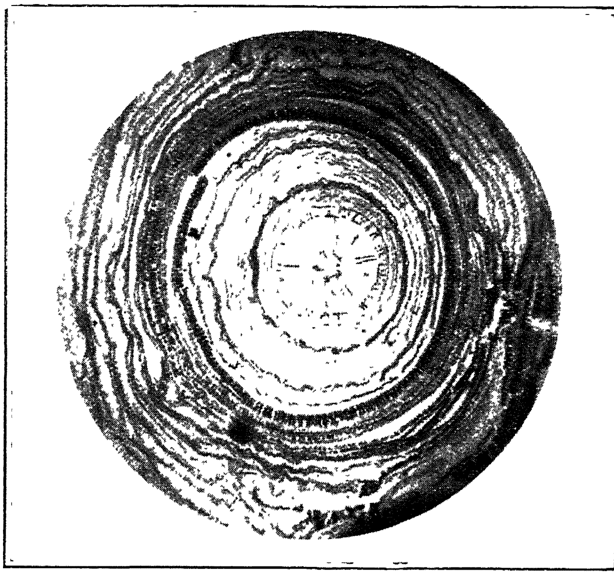

FIG. 1

1 centième de millimètre, dans l'intérieur du noyau; ils étaient semblables à ceux que j'ai signalés dans les perles de Pintadines du Golfe de Gabès et dans les perles de Modioles de la même localité. Je les considère comme des *spores de sporozoaires*."

Thirty-two pearls from the tissues of a *Pinna*, dredged in the Salcombe Estuary in February 1928, were kept in Dubosq-Bouin for about nine months to dissolve the calcium carbonate and to fix any soft organic matter that may be present. All the specimens were dehydrated, cleared, and sectioned by the usual method; four of these could not be completely sectioned as the nucleus fell out in the process. The sections were stained either in iron hæmatoxylin and eosin or in water-blue and safranin. From the work of Alverdes (*Zeitschr. wiss. Zool.*, Bd. 105; 1913), it is known that water-blue stains the conchyolin of the nacreous layer, and safranin the periostracum.

On microscopic examination, sections of twenty pearls showed that there were few concentric conchyolin bands in which the supporting organic matrix was radiating out in a manner similar to that found in the shell of *Pinna* as shown by Biedermann (*Jenaische Zeitschr. f. Naturwiss.*, Bd. 36; 1902; Taf. 1, Fig. 5); the arrangement of the layers in seven other pearls showed that it was identical with that found in 'white' pearls of *Ostrea edulis*, except that there were no discontinuous layers of brown horny material; one pearl had an alveolar layer round the nucleus, with the normal arrangement of concentric layers on the periphery, as shown in Fig. 1, and still another had an alveolar layer on the outside, added to the two layers already present as described in the previous one.

It was also observed that one pearl had small ovoid corpuscles in the nucleus, probably similar to those found by Dubois (loc. cit.); one had a network of conchyolin which stained blue, indicating that before decalcification there was a piece of nacreous material; eight had an irregular mass of conchyolin, the remnant of an amorphous layer; twenty-one had brown conchyolin which was not acted upon by either of the stains, and finally, the nucleus of one could not be ascertained. Thus it would appear that in *Pinna*, the origin of pearls is due to abnormal secretion of the epidermis, a view similar to that enunciated by Jameson (*Proc. Zoo. Soc.*, 1912) for the Ceylon pearl oyster.

C. AMIRTHALINGAM.

Zoological Dept.,
University College, London.

The Methodology of the Inexact Sciences.

ON the rare occasions when I dip into some book on one of the non-quantitative sciences, such as those which deal with folk-lore, analysis of literary documents, or the human unconscious, I am puzzled and a little scandalised by a canon of logic which appears to be very freely adopted in these branches of thought. It consists in the use of the following argument: "It is possible to work out an analogy between *A* and *B*. Therefore *A* must be the cause of *B*, or vice versa." This canon used to be used very freely in the interpretation of sacred writings, and especially of prophecy, but it seems now to have passed over intact into the sciences I have mentioned above.

To give one example: in the very interesting article on "Christmas Customs and their Origins" in NATURE of Dec. 22, it was stated that "the Cave of Mithra survives in the cult of the Manger" of Bethlehem. The reason implied for this attribution is that there are two analogies between the two cults—(1) That both relate to events which took place indoors (any event must take place either indoors or out of doors, so that the coincidence is not a very surprising one); and (2) that in both cults animals are represented. It happens that the Mithraic animals—the snake, bull, scorpion, and dog—are different from those found in the stable, but in any case amongst agricultural people animals are so ubiquitous that there seems to be nothing very remarkable in the fact of their presence. This, then, is the argument: 'In Mithraism and in the Catholic Crèche you have (1) an indoor transaction, and (2) animals present (although of different species and characters); hence the cult of the manger is a survival of Mithraism.'

Arguments of this type constantly recur in the non-quantitative sciences—notably in the phallic interpretation of dream symbols. They appear to me to be fallacious, for the reason that *it is almost always possible to trace an elaborate analogy between any two groups of events whatever, chosen at random.* Any biography can be used to interpret any dream: Freud's "Gradiva" affords an outstanding example of this fact.

There is, of course, no harm whatever in the innocent pursuit of tracing such analogies, but it seems extremely misleading to apply the same term,

'science,' to those studies which employ the method freely, as to other studies in which quantitative measurement or statistics play a part and in which objective verification is practicable. Would it not be preferable to coin some other term to denote the former—a suitable one could surely be found in the writings of Philo of Alexandria, who excelled in the method of research under discussion.

C. W. HUME.

14 The Hawthorns,
Finchley, London, N.3,
Dec. 31.

I HASTEN to reassure Capt. Hume. No right-minded anthropologist would regard the argument framed by him as scientific. A science need not be judged by its camp followers and aberrant devotees. Mathematical demonstration is possible only in proportion to the degree of abstraction. The criterion of proof in each science depends upon the character of its subject matter and the potentialities of the methods which that subject matter admits. To estimate the conclusiveness of a proof, apart from the general rules of logic, in any given subject must therefore, to a considerable extent, depend upon knowledge and training. Capt. Hume's example is not well chosen. The connexion between Christianity and Mithraism, as well as other forms of paganism, is dependent not upon one or two resemblances, which might be fortuitous, but upon a series of similarities sufficiently close to warrant their being regarded as identities, quite apart from the admission of the early Christian Church that borrowing and assimilation had taken place. THE WRITER OF THE ARTICLE.

Blue Rock Salt.

IT was suggested by Prof. Baly that the blue colour of certain specimens of rock salt from Stassfurt might be explained by a difference in energy content between the blue and the ordinary colourless salt, and that this difference might be manifested by a difference in the heats of solution of the two varieties.

That there must be a higher energy content in the blue form was shown by heating some of the blue product to about 350° C. in an electric muffle in a dark room. A distinct glow was observed soon after dropping a blue crystal on the floor of the muffle, and after the glow ceased it was found that the blue colour had disappeared without disintegration of the crystal. Colourless portions of rock salt, taken from different parts of the same sample, showed either no glow at 350° C. or only the faintest trace, which was probably due to the presence of a few specks of blue salt enclosed in the white.

No light was emitted on dissolving blue salt in water, nor could any radiation be detected by a panchromatic plate.

Several series of experiments were carried out on the relative heats of solution of the blue and colourless salt, in an adiabatic calorimeter, and by using the same range on the Beckmann thermometer throughout each series, any error due to scale inaccuracy was eliminated. These experiments resulted in a difference of only about 0·5 per cent, the blue portions having a smaller negative heat of solution, as was to be expected. This corresponds to a difference of only two thousandths of a degree between the falls in temperature on solution of the blue and white portions under the best conditions that could be attained.

Experiments were also carried out on the relative heats of solution of purified sodium chloride and of specimens of blue salt prepared by means of cathode rays, in the hope that a larger difference in the heats of solution might be obtained than in the case of the natural product. The difference was now found to be 1·5 per cent; but this cannot be directly compared with that obtained in the case of the Stassfurt halite, because the artificially prepared blue salt was found to give an alkaline solution, whereas the natural variety gives a neutral one. This points to a liberation of heat due to a reaction between metallic sodium and water, and it is therefore not justifiable to rely on the heat of solution as a measure of the energy associated with the coloured state in the case of the artificially prepared blue salt.

Whilst the investigation shows that there is a very slightly greater energy content in the coloured than in the colourless halite, the difference was found to be too small for accurate determination.

(During the preparation of pure sodium chloride it was observed that by fusing it in a platinum vessel in air, a product was obtained which invariably gave an alkaline solution. This is contrary to statements in the literature, and the matter is being further investigated both for sodium chloride and other similar compounds. The results will be published in a separate communication.)

F. C. GUTHRIE.

The Chemical Laboratories,
University, Liverpool.

Newly Discovered Superconductors.

AT the Glasgow meeting in September last of the British Association, I read a paper on investigations on superconductors which I am carrying out in the cryogenic laboratory, Leyden, in co-operation with Prof. van Aubel, of Ghent, and Mr. J. Voogd, of Leyden. In my opinion, the superconductivity of the metals is not only connected with the electron configuration in the atoms, but also with the atomic weight and perhaps with the zero-point energy (*vide* W. J. de Haas, *Journal de Physique*, **9**, 9; 1928). From this point of view the following investigations may be interesting.

Recently we have investigated not only pure metals, but also combinations of two metals in relation to superconductivity. First, combinations of a superconducting metal with a non-superconducting one, namely, copper, silver and antimony with the superconducting tin, bismuth with the super-conducting thallium. The combinations of antimony with tin and of bismuth with thallium become superconductors. The resistance of Ag_3Sn diminishes continually from about 3·4° abs. to 1·3° abs., without vanishing, however. (The resistance of the 'classical' superconductors diminishes within a temperature interval of $\frac{1}{30}$° to $\frac{1}{50}$° from a measurable to an unmeasurable value.) Perhaps this combination represents a transition case, as the combination of copper with tin (Cu_3Sn) does not become superconducting.

I formed the opinion, however, that combinations of two non-superconducting metals could also form a superconductor. The atomic weights of the metals considered are: copper, 63·57; silver, 107·88; tin, 118·7; antimony, 120·2; gold, 197·2; mercury, 200·6; thallium, 204·0; lead, 207·2; bismuth, 208. The eutectic alloy of gold–bismuth was chosen. As to their atomic weights, these two metals lie just below and just above the group of the heavy superconductors respectively. (The numbers of the electrons in the outer layers for gold, mercury, thallium, lead, bismuth, are 1, 2, 3, 4, 5 respectively.)

Again, in co-operation with Prof. van Aubel, who had prepared the samples, and with Mr. Voogd, the resistance–temperature curve was determined. The combination gold–bismuth really becomes superconducting. The fall of the resistance is very great. The

resistance, which is 0·7 of its value at room temperature at about 2·1° abs., has vanished $\frac{1}{10}$° lower. The level, from which the resistance falls steeply, lies about three hundred and fifty times higher than for the 'classical' superconductor mercury, and about a thousand times higher than for the 'classical' superconductor tin.

Of course, it may be that superconductivity is a much more general property than has been supposed until now. At 1·5° abs., however, neither gold nor bismuth is a superconductor.

W. J. DE HAAS.

University of Leyden,
Dec. 28.

The Arc Spectrum of Chlorine.

L. A. TURNER (*Phy. Rev.*, vol. 27, p. 397; 1926) discovered the fundamental or resonance lines of chlorine due to the transition $4M_2(M_2 \longleftarrow N_1)$. De Bruin (*Amsterdam Proc.*, vol. 30, p. 20; 1927) found a number of lines in the visible with the constant frequency difference of 530, and Laporte in a note to NATURE (vol. 121, p. 1021; 1928) announced the discovery by Asagoe of a set of lines between λ4700 and λ4200, which he ascribed to the transition $4M_2(N_1 \longleftarrow N_2)$.

In a paper to the *Indian Journal of Physics* (vol. 3, p. 67; 1928), it has been shown that if a group of successive elements (for example, Al, Si, P., .., .., K) be taken, the wave-numbers of the lines of the elements due to the transition $N_1 \longleftarrow N_2$, increase linearly with the atomic number. This enables us to predict that the lines of chlorine arising from the above transition will lie in the infra-red, the strongest line having the wave-length λ8400. The lines of chlorine which Laporte mentions cannot, therefore, be due to the transition $4M_2(N_1 \longleftarrow N_2)$, but may be due to the transition $4M_2(N_1 \longleftarrow O_2)$, forming the higher Rydberg sequence of the infra-red lines. Using a special kind of chlorine tube, I have been able to photograph these infra-red lines on a neocyanine plate. The lines lie exactly where they were expected. The quartet combinations, namely, $^4(PD)$ and $^4(PS)$, have been obtained, the $^4P_{321}$-differences being 530 and 340. The $^4(P\overline{P})$-lines lie beyond λ8700 and have not yet been obtained. With this data the ionisation potential of chlorine is estimated at about 13 volts.

It is interesting to note here that most of these infra-red lines seem to be identical with some of the unidentified lines in the solar spectrum as given in the "Revision of Rowland's Preliminary Table of Solar Spectrum Wave-lengths" by the staff of the Mount Wilson Solar Observatory. Infra-red lines of sulphur have been traced in the sun by Meissner (*Phys. Zeit.*, vol. 15, p. 668; 1914), but the corresponding argon lines are clearly absent. Chlorine lines seem to be present. It may not be impossible that, like the helium lines, these infra-red lines of elements from silicon to argon may come out strongly in the spectrum of the solar chromosphere.

K. MAJUMDAR.

Department of Physics,
University of Allahabad, India,
Nov. 25.

Salmon Disease.

I AM particularly interested in the reference to the work of Dr. F. H. A. Clayton and Miss Isobel J. F. Williamson on salmon disease which appeared in NATURE of Dec. 29, 1928.

As Dr. Clayton refers in his concluding remarks to the possibility of the existence of 'carriers' spreading salmon disease, the following note on the occurrence of this disease among coarse fish may be of interest to readers of NATURE.

In 1914 and 1915 this disease was very prevalent locally among gold fish both in private aquaria and in the laboratory stock. It also assumed epidemic intensity among roach in a private ornamental pond. The occurrence of this disease among coarse fish so well removed from any stream or contact with salmon was of considerable interest. An investigation was made and the results reported to the Board in 1915; from this report the following conclusions are quoted:

(1) That coarse fish are subject to a bacterial disease which resembles in many respects that occurring among salmon.

(2) That this disease, or a disease producing similar pathogenic conditions, occurs fairly commonly among coarse fish both in aquaria and in relatively open situations where salmon and similar fish do not occur.

(3) The great similarity between the diseases found attacking coarse fish and salmon, and also between the organisms isolated, suggests that it is one disease fairly frequent among coarse fish generally, and that occasionally it attains a marked virulence among salmon and is then known as the 'salmon disease.'

Since this investigation was made the disease has not been so prevalent and the laboratory stock has been relatively free, but roach taken from a local lake in May last were infected with this disease. It would appear, therefore, that the disease is endemic among coarse fish, where it may attain epidemic virulence as in the 1914–1915 outbreak, and that coarse fish may readily provide the necessary 'carriers.'

J. W. HAIGH JOHNSON.

Biological Laboratory,
West Riding of Yorkshire Rivers Board,
71 Northgate, Wakefield.

The Average Life Period of an Atom.

I QUITE agree with Dr. Jeffreys (NATURE, Jan. 19, p. 87) that a reader of my original letter would not have gathered much about Dr. Jeffreys' views on earth history from my remarks about the average life period of an atom. The whole point of my letter was that as the earth at present appears to be approximately in thermal equilibrium, the life period of a terrestrial atom must be very large compared with that of the universe. Dr. Jeffreys' contention that 13 per cent approximately of the present heat loss must, of necessity, be attributed to primeval heat, leaving only 87 per cent to be explained by all atomic disintegration processes, known or unknown, only strengthens this proposition.

Personally, I am not prepared to accept Dr. Jeffreys' view that the equation of heat conduction in a solid material is sufficient to determine the whole past and future history of the earth's crust. At certain epochs in that history it is possible that we may be confronted with the problem of a liquid substratum overlain by its own solid. In considering the probable history of such a case, it would appear not to be sufficient to consider the heat flow due to conduction in the upper solid alone. The transference of heat in the liquid layer by convection and the physical properties of the liquid must also be taken into account.

Readers interested in this problem might consult two papers by Dr. Joly and Dr. Jeffreys in the *Philosophical Magazine* for January 1928, and one by Dr. H. H. Poole and myself in the same periodical for March 1928.

J. H. J. POOLE.

Trinity College, Dublin.

Astrophysics and the 200-inch Telescope.

DURING the past few years, NATURE has published from time to time supplements containing the views of some of our leading astronomers and physicists on problems of the structure and history of the physical universe. These supplements have aroused widespread interest, and the progress which has lately been made, and is still going on, in physical astronomy is probably the most significant aspect of the scientific developments of our time. We may perhaps be pardoned for a feeling of pride that in Great Britain we possess some of the most brilliant workers in this field, whose labours have largely determined the direction of inquiry and inspired the forward march. It is a matter of intense satisfaction that we are second to none in the quality and extent of contributions to knowledge of the universe and its laws, and there is every prospect that the position which British astrophysicists have won will be well maintained in the years to come.

Of all inquiries, however, the study of the universe is the one in which an insistence on national boundaries is least appropriate. If British theoretical workers were asked to what they chiefly attribute the present progress they would undoubtedly reply: to the results achieved by the 100-inch telescope at Mount Wilson. Since that famous instrument was installed, not more than ten years ago, the new facts, of the utmost importance, which it has been the means of revealing, can scarcely be appreciated in their entirety and full significance. There is scarcely an advance in theoretical knowledge during that time that does not owe something, directly or indirectly, to the unrivalled light-grasping power and resolving power of this chief among telescopes. Every advance in knowledge depends in the last resort on an inprovement in means of observation, and behind every legitimate theory of the universe is a collection of photographs of fields of stars.

The proposal of the California Institute of Technology to erect a 200-inch telescope, to which we directed attention in NATURE of Nov. 3, is therefore a project of which it is scarcely possible to exaggerate the importance. We have received further particulars of this great undertaking from which it appears that the construction of the telescope itself is but one item in a scheme of wider scope. It is proposed to establish a new observatory consisting of two parts. "One of these will comprise the 200-inch telescope, with its building, dome, and auxiliary equipment to be erected on the most favourable high-altitude site that can be found within effective working distance of the associated groups of investigators and their extensive scientific equipment. The other will be an Astrophysical Laboratory on the campus of the California Institute. This Laboratory will serve as the headquarters in Pasadena of the Observatory staff and the Graduate School of Astrophysics. Its equipment will include instruments and apparatus for the measurement of photographs, the reduction and discussion of observations, and for such astrophysical investigations as can be made there to the best advantage. Its instruments for the interpretation of astrophysical phenomena will be designed to supplement those of the laboratories of the Institute and the Pasadena laboratory of the Mount Wilson Observatory. It will also include an optical shop, but the astrophysical instrument shop will be housed in a separate building, to avoid the effects of the vibration of machine tools."

The promoters of this far-reaching scheme approach the problem in a broad-minded manner which augurs well for its success. "In the operation of the telescope," the statement continues, "the same policy will be maintained which has been followed in the past at the California Institute and the Mount Wilson Observatory of inviting eminent authorities in astronomical and astrophysical research to use the instrument in connection with their investigations. It is hoped that in this way the Astrophysical Observatory will also become an international centre for research."

It is impossible to foresee what further knowledge may come to light if the proposal becomes an accomplished fact: the most important revelations are probably beyond our present powers of anticipation. No one could have foretold that Lord Rosse's great reflector would have revealed the spiral character of the extra-galactic nebulæ, or that the 100-inch telescope would have given us their distances and fine structure. A fairly well defined preliminary programme of research has nevertheless been drawn up. "The increased light-collecting power of the 200-inch telescope should permit further studies of the size and structure of the galactic system, the distance, radiation, and evolution of stars, the spectra of the brighter stars under very high dispersion, the distance and nature of spiral nebulæ, and many phenomena bearing directly on the constitution of matter. The possibility that a 40-foot Michelson stellar interferometer, designed to rotate in position angle, may be attached to the telescope is under consideration. The measurement of the separation of the components of any spectroscopic binary stars within the range of such an instrument would give very complete information regarding the nature of these systems and the masses of their components."

The chief difficulty in the matter is of course the construction of the large mirror, and it remains to be seen whether the confidence of the promoters will be justified. A 22-inch disc of fused silica is already being experimented on. It is proposed to coat it with a layer of bubble-free silica, and afterwards to repeat the experiment with a 60-inch disc, which would be used as one of the minor mirrors of the telescope. If this proves to be satisfactory, a still larger disc will be made before the casting of the 200-inch disc is attempted. It is intended to employ the exceptionally small focal ratio of 3·3 for the 200-inch mirror. "The field of sharp definition in the principal focus of such a

mirror will be small, but the possibility of photographing extremely faint stars, especially in the spiral nebulæ, makes such a powerful concentration of light highly advantageous. Dr. Ross, who will devote himself to these optical problems during the coming year, also believes that a lens can be designed, for use in the converging beam, which will serve when desired to give a much larger field, also with a short equivalent focal length. It is planned to use a Cassegrainian combination with a ratio of F : 10, having a sharp field 30′ (17 inches) in diameter, for spectrographic and other work. A Coudé arrangement similar to that of the 100-inch Hooker telescope, permitting the images of celestial objects to be formed in a constant temperature laboratory, for study with large fixed spectrographs, radiometers, or other auxiliary instruments, is also projected."

The device of overcoming the difficulties of casting so large a disc by making only the surface layer of homogeneous material recalls a somewhat similar idea put forward by Sir Norman Lockyer so long ago as the year 1884. He proposed the construction of an 8-foot reflector, of which the body of the mirror was to be of porcelain and the surface of glass. At that time astronomical photography was in its infancy, and Lockyer's ideas of the work which could be done with such an instrument, revolutionary as they then were, have a very modest appearance beside the schemes now contemplated.

In the matter of mounting the telescope, much additional study will be required before even a preliminary design can be adopted. It is hoped that "an equatorial design of the fork type, of sufficient rigidity to carry a 40-foot interferometer and meet other severe requirements, will soon be worked out."

In selecting a site for the instrument, precise measures of the 'seeing' rather than estimates have been aimed at. Dr. Anderson has devised "a simple means of measuring the atmospheric oscillations of star images under a power of 600 with a 4- or 5-inch telescope, and Mr. Ellerman has tested it satisfactorily on Mount Wilson, in comparison with the estimates of experienced observers with the 60-inch and 100-inch telescopes. Preliminary observations with this method by Messrs. Ellerman and Humason have been made at Palomar Mountain and 'Horse Flats' (north of Mount Wilson), and some tests made by Dr. Abbot and Mr. Moore at Table Mountain show that this site, like the others, deserves careful examination. Dr. Hubble, with the kind co-operation of the authorities of the Grand Canyon National Park, is engaged in the investigation of conditions near the Grand Canyon and at other points on the high plateau area of Central and Northern Arizona."

The thoroughness which is evident in this part of the plan is characteristic of the whole. Not only the installation of the great telescope itself, but also the arrangements for all the auxiliary instruments and apparatus used to receive, record, and interpret the celestial images, are being subjected to a searching inquiry by an army of the greatest experts in the United States. If determination, skill, and energy can bring the plan to a triumphant issue, it is assured of success. We trust that the practical difficulties of so enormous an undertaking will not prove insurmountable.

The Transport of Carbohydrates in the Plant.

VERY little is certain as to the movements of carbohydrates in the plant. It is generally agreed that the green plant can build them up for its own needs in leaves exposed to the light, and that these supplies are then utilised in growth throughout the plant, so that considerable movements of sugars must take place from the leaves to the roots and fruits and various storage organs. There is no agreement, however, as to the tissue through which this movement takes place. Only two tissues, regularly present in this plant axis, are so extended in the longitudinal direction as to be very likely to convey such substances for long distances through the axis; these are the wood or xylem, and the phloem or bast. Usually, the sieve-tubes of the phloem have been regarded as the channels of sugar transport, as micro-chemical observations, such as those of Prof. Mangham, seemed to show considerable quantities of sugar in these tissues. The phloem in many trees is confined to a narrow layer near the periphery, so that it is possible to cut this channel completely by removing a narrow strip of tissue from the outside of the stem, and there is evidence that such ringing experiments always interfere with carbohydrate transport. Prof. H. H. Dixon pointed out, however (NATURE, vol. 110, 547-551: 1922), that the xylem sap usually contains appreciable quantities of sugar, and that in the ringing experiment it is very difficult to remove the phloem without doing some damage to the wood. As a result, the wood may be partially blocked, so that the interruption of the carbohydrate movement, attributed to the ringing of the phloem, may be really due to the partial choking of the xylem channels.

In much of the experimental work done to elucidate this problem, the transfer of carbohydrates through the region of the axis experimented upon is gauged by the amount of growth afterwards made as the result of supplies assumed to come from sources on the other side of the ring. Thus Prof. Otis F. Curtis has published a series of observations upon ringed shoots which were defoliated above the ring, and as a result made little growth, presumably through the failure of supplies to cross the ring. In such experiments the plants have obviously to be left for some time following the original ringing operation, and though Prof. Curtis has on many occasions followed up his observation of growth by quantitative analyses of his plants for carbohydrates, nitrogen, etc., it is difficult to know how much the redistribution observed has been determined by metabolic activities connected with growth, and how much it has been directly the

result of the interruption of translocation in the phloem. None the less, the work of Prof. Curtis has established a very strong presumption that the phloem is at least very active in the transfer of carbohydrates and probably many other substances through the axis of the plant. In two recent papers by Messrs. Mason and Maskell in the *Annals of Botany* (vol. 42, January 1928 and July 1928), a great deal of new evidence is supplied which points in the same direction. The Empire Cotton Growing Corporation has recently issued a reprint of these papers,[1] which form an outstanding contribution, based upon an intensive study of the cotton plant, to the solution of the general problem of the transport of carbohydrates in the higher plant. The papers occupy together more than 120 pages, and they describe much suggestive experimental work, with critical discussion of procedure and results, for which reference must be made to the original papers.

The experimental method adopted by Messrs. Mason and Maskell has been to follow, by analytical methods that permitted of certain standard determinations on numerous samples in a limited time, the changes in carbohydrate content in isolated samples of leaf, wood, and bark (the latter tissue including the phloem) within periods of time usually not greater than two or three hours. Sucrose, reducing sugars, and reserve carbohydrates were estimated separately, and the results expressed on the basis of the residual dry weight (total dry weight less carbohydrates) as a quantity that is less liable to fluctuation than either fresh weight or dry weight. Unfortunately, at each sampling an experimental plant is sacrificed, so that large numbers of plants of one strain of Sea Island cotton were grown under as uniform cultural conditions as possible, several samples taken and analysed separately on each occasion, and statistical methods applied to the whole series of results obtained in any one experiment, so that significant correlations and differences might be determined. In these experiments, therefore, any movements of carbohydrates that may be indicated will be the direct result of a fairly rapid longitudinal movement of these substances through the tissues, and not the indirect result of growth activities, which are not likely to produce very appreciable changes in such short time periods.

The immediate result of the new experimental method was to establish a significant correlation between the diurnal variation in the concentration of sugars in the leaf with similar variations in the bark, but not usually in the wood. At a distance some 50 cm. or more below the leaf, the variation of concentrations in the bark seems to follow the same curve, but is two or three hours later in reaching similar points on the curve. Reserve carbohydrates, which fluctuate greatly in the leaf, show little or no change in wood or bark, and are not considered further in the present brief discussion. In experiments in March, fruit bolls were included, and samples of wood and bark lying between leaf and boll. The result was to show significant correlations with similar time lag in the sugar content of leaf and bark and the dry weight increase in the developing fruit.

In September and later months, the results of ringing experiments were examined by the same methods at six-hourly intervals after the ring was made, with the result that above such a ring, made below the leafy region of the plant, an accumulation of sugars was soon observed in both wood and bark, whilst in the $6\frac{1}{2}$ inches of wood and bark just below the ring there is a marked fall in total carbohydrates. In this case correlated changes were noted in both wood and bark, and these and other experiments suggest to the investigators that an accumulation of sugars in the bark at any region is followed by a slow radial transfer of sugar into the wood in this region. Other ringing experiments, however, in which flaps of bark were lifted off the wood and separated from it during experiment by paraffined paper or vaseline, showed that, provided these strips of isolated bark remained connected to the foliar region above by continuous channels in the bark, accumulation of sugar still took place in them, though they ceased in the wood in the same region.

These experiments, on the whole, seem to provide very definite evidence that the major movement of carbohydrates from the synthetic centres of the leaves takes place through the phloem, though the possibility of carbohydrate movement under certain conditions in the xylem is, of course, not excluded. Experiments in the second paper, in which different regions of the phloem are analysed separately, suggest that the inner region, which consists more predominantly of sieve tubes, and possibly to a large extent of developing ones, is the region in which most of the longitudinal movement takes place, because the concentration of sucrose is much higher in the inner region, so that the concentration gradient of sucrose outwards in a radial direction is 300 - 500 times as steep as in a longitudinal direction.

Whilst Mason and Maskell have thus supplied striking experimental evidence in favour of movement of sugars through the phloem, they do not fail to point out the difficulties in the way of understanding this phenomenon. Changes of sugar concentration in the leaf sap are followed by changes in the phloem of the axis, as if the concentration gradient determined the movement of sugar, as it would do in the case of movement by diffusion. But from the rapidity with which these concentration changes are registered at distances of more than fifty centimetres, they calculate that the longitudinal movement of the sugar in the sieve tube is at least 20,000 times too fast to be due to diffusion of sugar through an aqueous medium. Furthermore, there is another stumbling-block in the way of regarding the concentration gradient as the driving force determining movement. In the leaf the variation is principally in reducing sugars, and this is followed by changes in the concentration of sucrose in the phloem. They conclude,

[1] "Memoirs of the Cotton Research Station, Trinidad, Series B, Physiology, No. 1. Studies on the Transport of Carbohydrates in the Cotton Plant." By T. G. Mason and E. J. Maskell. Empire Cotton Growing Corporation, 2 Wood Street, Millbank, London, S.W.1. 1928.

therefore, that sugar moves in the sieve tubes by a process analogous to diffusion, but that the mechanism by which such high absolute rates of movement are maintained is unknown.

In this connexion the possibilities of streaming movements in the segments of the sieve tube might be worthy of further examination. It is a well-known fact that in many elongated living cells the protoplasm of the cell rotates within its wall at speeds which would permit of movement along the cell at rates of several centimetres an hour. There is still the need of transfer from one rotating protoplast to the next on the opposite side of a cellulose wall, but the distance thus traversed by diffusion will not be more than $\frac{1}{100}$ the total distance travelled in the sieve tube. This method of transfer would then result in movement, which would obey the concentration gradient, and yet be very much more rapid than diffusion in water. Mason and Maskell apparently reject it because protoplasmic rotation is rarely seen in the adult sieve tube—although it has been reported by Lecomte. On the other hand, in sections of young developing phloem, as in tangential longitudinal sections through the inner bark of trees, which are mounted in water, most lively streaming movements are usually visible. Strasburger has also shown how readily similar movement can be seen in long cells in the phloem of herbaceous plants which were very possibly developing sieve tubes.

Whilst the adult sieve tube, therefore, may act as a reservoir, which is gradually depleted by local utilisation of its contents, the streaming segment of the developing tube may be responsible for the rapid longitudinal transfer of the carbohydrates. Mason and Maskell eliminated, so far as possible, the complications introduced by growth activities by cutting down the duration of their successive experiments so far as possible. But the inner segment of the phloem in which the very high concentration of sucrose was observed would contain all the young sieve tubes developing from the cambium.

This consideration might throw some light upon a gradient of reducing sugars in the leaf being followed by an equivalent gradient of sucrose in the phloem of the axis. Any enzyme synthesis of sucrose from glucose and fructose *in vitro* has so far proved impossible, and in the light of modern knowledge of the difficulties of sucrose synthesis (NATURE, Oct. 13, 1928, p. 578), this is quite explicable. In the sieve tube it is difficult to see how the direct conversion of reducing sugar to sucrose is to be brought about, but if the reducing sugars are employed in the construction of living protoplasm, which is then utilised in the construction of a new series of sieve tubes from the cambium, in the differentiating sieve tube sucrose may be found instead of the hexoses which originally entered into the composition of the protoplasm. J. H. PRIESTLEY.

Obituary.

DR. J. W. L. GLAISHER, F.R.S.

DR. J. W. L GLAISHER died on Dec. 7, 1928, at the age of eighty years. At the time of his death he was the senior among the actual fellows of Trinity College, Cambridge; was the senior member of the London Mathematical Society; and was almost the senior in standing among the fellows of the Royal Society and the fellows of the Royal Astronomical Society. In his prime he ranked as one of the recognised English pure mathematicians of his generation, pursuing mainly older subjects by methods that were direct and simple. Throughout his life he was devoted to astronomy, chiefly in its mathematical developments. In the later part of his life he attained high rank as an authority on pottery, of which he had made a select collection, famous and invaluable.

Glaisher was the elder son of James Glaisher, F.R.S., himself an astronomer, a mathematician specially devoted to the calculation of numerical tables, and a pioneer in meteorology, sometimes at the risk of his life. For the father was an aeronaut of note; with Coxwell in 1862 he made the dangerous balloon ascent which reached the greatest height (about seven miles) ever recorded by survivors. This aeronautical achievement inspired a popular music-hall song of the day; and "Up in a balloon, boys," was sung by the undergraduate gallery in the Cambridge Senate-House as the aeronaut's distinguished son was being admitted to his first degree.

James Whitbread Lee Glaisher was born at Lewisham, in Kent, on Nov. 5, 1848. He was sent to St. Paul's School in London, which in 1867 he left as the Campden Exhibitioner. In that year he went into residence at Trinity College, Cambridge; and that was his home for the rest of his life. He was duly elected a scholar in 1868. He graduated as Second Wrangler in 1871, the Senior Wrangler being John Hopkinson, also a Trinity scholar, later the distinguished engineer. He was elected a fellow of his College in that same year; the election was doubly notable, for it was the first held after the parliamentary removal of dissenters' disability of fellowship tenure, and all the three successful candidates (the other two being Hopkinson and the present Dean of Ely) were elected at their earliest date of candidature.

Glaisher was appointed assistant tutor of his College on Oct. 12, 1871, an office that qualified for the lay retention of his fellowship, though celibate restrictions existed for another eleven years. He was tutor from 1883 until 1893, for the then customary normal period. He remained a lecturer on the mathematical staff until 1910, having been continued beyond the normal maximum period by the College Council.

Glaisher never held any permanent appointment outside Cambridge. It was currently believed that, on Airy's retirement in 1881, he refused the office of Astronomer Royal which had been offered to him; the duty would, of course, have exacted

residence at Greenwich. He remained a bachelor. When first a fellow, he lived in Whewell's Court: his rooms then resembled a rather cheerless set of chambers, with pigeon-holes and cabinets for documents, pamphlets, notes of calculations, and bookcases for his growing library. In 1885 he changed into a spacious set of rooms, with a view down the lime avenue across the river away to the Coton fields; with the change, there came a change in the appearance of his surroundings. His library naturally continued to increase. But he began to collect objects of beauty and rarity, in arts of several kinds. Once begun, his collection never ceased to grow, always under his unlimited and unstinted care; yet his favourite working-corner between the fireplace and the window, remembered by every visitor, remained his mathematical shrine of duty to the very end of his life; and, there, a jealously reserved portion of each working day in Cambridge was spent in his mathematical researches with a regularity that never failed.

His personal pursuits, outside his teaching, his research, his attendances at scientific meetings, and his passion for collecting, were varied. He was a vigorous walker, and covered ground at an amazing pace. In his youthful donnish days he rode a bicycle of the 'penny-farthing' type, his tall lean frame lending itself to the claims of that forgotten machine; and he was an active president of the Cambridge University Bicycle Club. In his middle years he often went to the United States to spend vacations with his friends Prof. and Mrs. Woolsey Johnson and their sons; or when they crossed the Atlantic he would have them in Cambridge, or would travel with them on the Continent. He maintained a wonderful vitality and a surprising appearance of comparative youth, even in his early seventies. It was only in the last few years that his health gave way, and it broke badly; but the spirit remained.

In 1875 Glaisher was elected a fellow of the Royal Society. His first original paper, full of cognate historical matter, dealt with the non-evaluable sine-integral, cosine-integral, and exponential-integral, and contained elaborate tables of those integrals, calculated by himself; it had been written by 1870, while he still was an undergraduate, and was communicated by Cayley. He served on the Council of the Society for three periods, 1883–84, 1890–2, 1917–19, during the last of which he was one of the vice-presidents. In 1913 he was awarded the Sylvester medal of the Society.

He had joined the Royal Astronomical Society in 1871, and became a member of the Council in 1874; he remained a member of that Council for the rest of his life, and his fifty-four full years of continuous membership may be a 'record,' to use a popular word of to-day. He held the office of secretary from 1877 until 1883. He was president of the Society in two distinct periods of office, 1886–88, and 1901–3; during those tenures, it became his duty to present the Medal of the Society to G. W. Hill (1887), to Auwers (1888), to Kapteyn (1902), and to Struve (1903), delivering masterly summaries of the original work of the several recipients on the respective occasions.

Throughout his scientific life Glaisher devoted much attention to the affairs of the London Mathematical Society. He was elected a member on Feb. 8, 1872, and he became a member of the Council in the succeeding November; he retired from that body in 1906, after a continuous service between those dates. He was vice-president in 1880, 1881, 1886, 1887; and president in 1884–85. Thus his own experience gave him full knowledge of the development of the Society almost from its beginning. At a meeting in 1926 to celebrate a belated jubilee of its existence, he gave a charmingly genial account of its activity, particularly of its early stages, and of the personal inspiration of members like Cayley, Sylvester, H. J. S. Smith, and Clifford. In that account there was one defect, characteristic of the man: it ignored his own contributions to the Society's influence upon mathematical science. He was awarded the De Morgan medal in 1908. There is no record of his reply of thanks on the presentation; but, as later in 1926, his words—he would have disdained to call them a speech or an address—were the expression of a friendly retrospective review of the Society, of which (so little did he say of himself) he might at the moment have been the least known member, instead of the most honoured.

In early and middle years Glaisher was a frequent attendant at the annual meetings of the British Association. He took an active part in its work, as secretary of Section A for a considerable period, and as a member of several committees dealing with tables of numbers, or with reports upon the progress of various branches of mathematical science. He was president of Section A at the Leeds meeting in 1890: his address dealt with relations between applied mathematics and pure mathematics, at a time when it still was not unnecessary in England to plead occasionally for a fuller recognition of pure mathematics.

It was a matter of course that he was a member of the Cambridge Philosophical Society. He often served on its Council in various capacities, frequently contributed papers to its *Proceedings*, and was in regular demand as a referee upon papers contributed by others. He was president of the Society in 1882–84.

Glaisher proceeded to the newly established degree of doctor of science at Cambridge in 1887; at the time of his death he had come to be the senior in standing among his fellow doctors. He was made an honorary doctor of science by Dublin on the occasion of the tercentenary celebrations of Trinity College; and, later, he received the same honorary degree from the Victoria University. He was one of the British honorary fellows of the Royal Society of Edinburgh, as also of the Manchester Literary and Philosophical Society; and he was a foreign member of the National Academy of Sciences of Washington. He was also president of the Cambridge Antiquarian Society in 1899–1901, an office that is uncommon for a man so actively engaged in mathematical teaching and research

and in the current administration of scientific societies (in the most restricted sense of the term). But, as already indicated, the study of pottery was one of his hobbies: what began as a hobby developed into one of the absorbing interests of his life: and he became[1] "... one of the leading pottery collectors of his time. His attention in this direction was at first occupied by Delft ware, but from the Dutch pottery he was led to take an interest in the English wares made in emulation of it, and so in other types of English pottery of early date. The collection which he had been forming through a long period of years is, as regards the 17th and early 18th centuries, the largest collection of English pottery ever made; and it is satisfactory to reflect that, by becoming the permanent possession of the Fitzwilliam Museum, in which a large part of it has already been for many years on view, it will be accessible to all who wish to study it. . . ." It may be added that he had made (and at the time of his death was still engaged in) a catalogue of his collection in nearly forty manuscript volumes, which may well prove a valuable addition to the literature of ceramics.

When he was a lecturer at Trinity, Glaisher had his share of work that belonged to the ordinary round, such as astronomy or hydrostatics for the Tripos range, even a 'poll' lecture. His happiest efforts were devoted to subjects such as differential equations, combination of observations, elliptic functions. In each of these subjects his lectures in the late 'seventies were a revelation to students. The Tripos was never mentioned: the subject was expounded. His exposition was the more illuminating because concurrently (though unknown to his class) he was writing paper after paper dealing with details unmentioned in the text-books (if any); and enterprising students were encouraged to proceed to original sources. Such lectures were an intellectual treat. Then his course on combination of observations was at once critical, synthetic, constructive; he was singularly clear in setting forth assumptions made and the restrictions imposed by the assumptions. But, above all, he revelled in elliptic functions. It was not that he was opening unknown regions of new theories; at that date he never even mentioned the more comprehensive general theory of functions, scarcely known in Cambridge, even by title; but his results were a sheer development of Jacobi's work, the calculations being made with the ease of a controlling master. Some of us who were members of his class used to believe that he had discovered all possible formulæ in elliptic functions and q-series, which were being incorporated in an expected treatise in the grand style. His enthusiasm was infectious; in his lectures there was a human note, something of the nature of the man, a little fun, a little whimsical touch now and then, not untypical of that geniality which marked his intercourse with fellow-men.

Yet Glaisher never published a volume of his own. Perhaps the sheets of that treatise on elliptic functions existed only in our undergraduate imaginations; perhaps they ceased gradually when he found that much of his presentation of the subject was only an incident in the wider theory of functions. Perhaps also, in the midst of his own researches, he was reluctant to devote the time and the labour that are demanded by the preparation of a continuous treatise; there is a germane passage in his presidential address to the London Mathematical Society which might be an autobiographical confession of his own hesitation in attempting such a task. But when others went forward, sometimes stimulated by himself, he was ever the first and the most generous in the recognition of their labour.

The tale of Glaisher's separate papers, mathematical and astronomical, was large, amounting to something like four hundred in all. They were not distributed evenly over his long scientific life. Thus, down to the end of 1873, when he was only twenty-five years of age, he had published more than sixty papers, not all of them brief. In the next ten years—with him, as with many men, the most prolific period of production—he published more than a hundred and fifty. In 1883 he became tutor of Trinity, and held that busy office for the canonical period of ten years; even so, he found leisure enough to produce some fifty papers in that time; and he continued this rate of production more or less to the end, amid the growing absorption of his pottery and, even latterly, in spite of the distractions of discomfort and pain and ill-health.

The subjects over which his published investigations range belong to certain well-defined regions. Glaisher had an unfailing interest in the history of mathematics; he would range over the historical introduction of the plus and minus signs, over the work of Napier and Briggs in the construction of logarithms, to a treatment of recent changes in the Mathematical Tripos. He was fascinated by sheer arithmetical computation and revelled in the construction of numerical tables; or he would be absorbed in the properties of certain numerical functions in the theory of numbers at large. Weird series and extracted identities were an unfailing attraction for his mental activity. Differential equations, mainly ordinary linear equations and their integration in series, absorbed much of his earlier attention. In England down to his time, progress in this subject had centred in formulæ that were 'elegant'; 'symbolic' solutions had been accumulated by the ingenuity of mathematicians like Leslie Ellis, Gaskin, Boole. Of all this lore Glaisher was the master and, in its range, a creator. Yet, wandered he never so far afield, he returned time and again to his beloved elliptic functions.

Mention also must be made of the addresses Glaisher prepared, some of them official, some of them personal tributes. Among the latter may be recorded his Nature notice of Cayley, early in 1895: his biographical notice of J. C. Adams, prefixed to the "Scientific Papers": and the introduction to the "Collected Scientific Papers of

[1] For the following estimate, extracted from a part of the (unsigned) obituary notice of Glaisher in the *Times* of Dec 8, 1928, I am indebted to Mr. Bernard Rackham, of the Victoria and Albert Museum.

H. J. S. Smith." He was at his appreciative and genial best in general addresses. His careful lecture, delivered in the ante-chapel of Trinity in 1887, in commemoration of the bi-centenary of the publication of Newton's "Principia," was a wonderful tribute to a great spirit. His address as the president of the London Mathematical Society in 1890 is a valuable monograph on the long history of the Senate-House Examination, more commonly called the Mathematical Tripos, since 1824. The last of his addresses, in 1926, already quoted, may continue to stand as the best authentic history of the early stages of the London Mathematical Society.

In person Glaisher was very tall, slim all his days, with an upright figure which even his long illness could only partially bend. His smile of appreciation was delightful and infectious; when appreciation waxed into admiration, his attractive eyes could glow with sympathetic delight. He was singularly fluent in speech, though he never aimed at eloquence; yet dignified passages abound in his formal addresses. He was a don, not of the old-fashioned type, scarcely indeed of any recognised type; there was no shred of pomposity; there was a persistent note of good-nature, not devoid of the occasional touch of whimsical mischief, with which he sometimes would quiz too seriously solemn persons. The deeper notes of human feeling were not wanting when, as occurred to him during his tutorship, he had to help others to face issues of life and death.

In mathematical science Glaisher now appears to have been a man mainly of stimulating influence upon others, and an inspiring teacher, rather than a pioneer whose manifold contributions to his science could be proclaimed as notable and memorable. The earlier years of his teaching at Cambridge were a time of transition in the mathematical thought and activity of the University. Cayley was almost a voice crying in the wilderness; and Glaisher himself described Cambridge pure mathematicians of those days as generals without armies. When he ceased teaching, Cambridge pure mathematics had gone far beyond his active vision, mainly under men whom, as his students, he had encouraged and stimulated at the beginning. His influence was rather that of the inspired preacher and herald. His voice was that of a great teacher, yet not in any way similar to the great Cambridge coaches of the past; for throughout his life he was ever a contributor to the knowledge of his science as well as a guide through ranges of knowledge outside the conventional examinational learning. He was a distinct personality in his day; a stimulus to other men, especially young men who came within the sphere of his influence; and he has left a name, high among the noted names of his own generation, in two widely different fields of constructive thought and human activity. A. R. F.

WE regret to announce the following deaths:

Sir William Boyd Dawkins, F.R.S., honorary professor of geology and palæontology in the Victoria University of Manchester, the doyen of students of prehistoric man, on Jan. 15, aged ninety-one years.

Dr. H. J. H. Fenton, F.R.S., honorary fellow of Christ's College, and formerly lecturer in chemistry in the University of Cambridge, on Jan. 13, aged seventy-four years.

Prof. Wm. North Rice, emeritus professor of geology in Wesleyan University, president in 1891 of the American Society of Naturalists and a vice-president in 1905 of the American Association for the Advancement of Science, on Nov. 13, aged eighty-three years.

News and Views.

THE paper by Prof. A. S. Eddington on the charge of an electron which appears in the January issue of the *Proceedings of the Royal Society* (vol. A, 122, p. 358), and was read and discussed at the meeting of the Society on Jan. 17, is based upon the fundamental principles of the theory of relativity and of the new mechanics. The so-called exclusion principle of the statistics of Fermi and Dirac prescribes an interaction of two electrons; this interaction is identified with their electric repulsion, and the details of the latter phenomenon can thus be predicted on essentially statistical grounds. The problem is taken to be one of a 'space' of sixteen dimensions, and it follows that the ratio $hc/2\pi e^2$ (where h, c, and e have their usual significance of Planck's constant, the velocity of light and the electronic charge respectively) should be simply the number of symmetrical terms in an array of sixteen rows and sixteen columns, which is 136. The experimental value of the ratio is 137·1, but Prof. Eddington believes that the discrepancy, although some three times the reputed probable error of experiment, does not originate with the theory. Prof. Eddington's conception of the meaning of the factor $2\pi e^2/hc$ can be best given in his own words. It "expresses a kind of property attributed to every pair of points in space; it turns space from a mathematical conception into a possible site of physical phenomena by associating with a pair of points some degree of probability that they may be the scene of this interaction. There is no room for elaborate integrations or for differential equations in the theory of such a fundamental factor." Again: "Modern theory has virtually abolished all structure of an electron," and with this, the expectation "that the value of e would depend on the singular solution of some differential equation expressing the transition from charge to field."

THE issue of the *Proceedings of the Royal Society* for Dec. 3 (Series A, vol. 121, No. A788) is especially interesting to students of quantum-mechanics; it contains no less than five papers which are excellent examples of the process of consolidation going on at both ends of the new theory. Any new theory, naturally enough, especially one developed at the rate of the theory of quantum-mechanics, is liable to be presented at first with a lack of complete-

ness, symmetry, or elegance. The lack of such elements is of course no ground for criticism, but it may prove a stumbling-block to further advances or cause unnecessary difficulty to the student. At the applications end of the new theory we find here papers by Temple and Nordheim—one presenting with really delightful elegance the quantum theory of the scattering of electrons by the field of force of a bare nucleus, the other completing the theory of the emission and reflection of electrons by clean metal surfaces—a theory which is proving of great help in the understanding of thermionic phenomena. At the foundations end of the theory there are papers by Eddington, Whittaker, and Flint. These all aim in different ways at expressing the principles of quantum mechanics in more general or more symmetrical ways than have yet been achieved. The results obtained at this end of the theory are always harder to appreciate than those of the other end; but one cannot avoid the feeling that further steps in the development of the foundations of the theory will not be long delayed.

ON Jan. 28 occurs the centenary of the death of Thomas Tredgold, who, though he died at the early age of forty, yet during the last ten years of his life gave the engineering world three works of first-class importance: "Elementary Principles of Carpentry," an "Essay on the Strength of Cast Iron," and a "Treatise on the Steam Engine." Though not destined to rise to the same eminence as his contemporaries Rennie, Fairbairn, or Stephenson, like them he started life with no advantage of environment, and like them he possessed an untiring industry. Born at Brandon, Durham, on Aug. 22, 1788, he received a village school education, and then at the age of fourteen was apprenticed to a cabinetmaker. From 1808 until 1813 he worked as a journeyman carpenter in Scotland, from 1813 until 1823 was an assistant in the office of a relative, William Atkinson, a London architect, and for the last few years of his life practised as a civil engineer in London. His "Principles of Carpentry," of 1830, was the first serious attempt in England to determine practically and scientifically the data of resistance; his essay on cast iron of 1824 was the earliest systematic treatise on that subject, while his book on the steam engine of 1827 was used by later writers, and enjoyed a popularity equal to that of the later works of Bourne and Rankine. Besides these separate works, which went through several editions, Tredgold wrote valuable articles in the "Encyclopædia Britannica," Thomson's *Annals of Philosophy*, and Tillock's *Philosophical Magazine*. He died in London and was buried in St. John's Wood Chapel Cemetery.

THE recent official announcement that the Government will ask Parliament for a vote of 5½ million pounds for future forestry work in Great Britain will be regarded with satisfaction by all who realise that this matter is one of economic importance to the nation, and should stand outside of party politics. The Forestry Commissioners were appointed, under the Forestry Bill of 1919, for a period of ten years, which comes to an end in April of the present year. A sum of 3½ million pounds was sanctioned for the first ten years' work. The Government now intends asking Parliament to sanction the continuance of the work of the Forestry Commissioners, increasing the grant for the next two years by 2 million pounds. In addition, the Commissioners anticipate receiving a total revenue from forest receipts of £1,400,000 during the next ten years. With these sums they expect to provide 225,000 acres of new plantations, to devote £1,000,000 to forest workers' holdings, and to make grants for other purposes, including the planting of municipal and private lands and forestry education and research.

THE ten years' work of the Forestry Commissioners now coming to an end has not proceeded without some of its operations being called in question in more than one part of Great Britain. This has proved rather an unfortunate aspect of the new work, since it has led to the attitude and acts of the Commissioners being regarded with suspicion by many who should have been secured as active allies. From the professional point of view the forest policy of the Commission, where such has been apparent, is open to grave doubts. The concentration, for example, on the formation of coniferous plantations (124,000 acres), and the total neglect of our valuable British broad-leaved species (4000 acres only in the period), has been strongly criticised. On the other hand, the Commission has put through a great deal of good work, and its well-wishers will hope to see it continued. It may be suggested, however, that the House of Commons, when considering this vote, should make itself acquainted with the work undertaken during the past ten years. Over that work the House has had little control, since the Commission, unlike all other departments of the State, is not under a Minister of the Crown.

THE second annual Report of the Oxford Preservation Trust, recently issued, gives an interesting record of the past year's achievements in the way of saving many of the sites in and around Oxford from the damage done to the amenities of the city by ill-considered building operations. An excellent map which accompanies the report shows five several plots of country within the five-mile radius which have been secured from the intrusion of the speculative builder by private benefaction and by the present Trust and its predecessor. The fauna and flora of the Oxford district are well known to be of a rich and varied character, as was amply shown by the volume on the natural history of the district brought out under the editorship of Commander J. J. Walker at the time of the meeting of the British Association in 1926. Even then the growth of the city had done much to deprive the immediately surrounding country of its suitability for the support of wild life; but it is satisfactory to know that some compensation for the loss is to be found in the sites saved from further encroachment through the activity of the Trust. In the words of Prof. E. G. R. Waters, speaking of the micro-lepidoptera, "the many sheltered woods and copses, rough pastures and swampy meadows, which are the principal habitats of these delicate and local insects,

have been much reduced by the constant advance of cultivation, cattle, building, and (most destructive of all) golf-links; but the remarkable concentration of lepidopterous life in some of the surviving localities partly compensates for what they have lost in extent." The reconciliation of commercial with æsthetic aims within the city itself—a still more difficult problem—is also being taken in hand by the Trust, which makes a strong appeal for pecuniary help.

AT the time of writing, little is known about the strong earthquake that, at 7.24 A.M. on Jan. 17, destroyed many buildings at Cumana, an important seaport town of Venezuela. Though the damage to the town is considerable and is probably greater than the early reports indicate, the earthquake seems to have been far inferior in strength to the great shocks that destroyed the town on Oct. 21, 1766, and Dec. 14, 1797. The latter earthquake, which occurred nearly two years before Humboldt's visit to the country—he himself felt two of its after-shocks on Nov. 4, 1799—is described in his "Personal Narrative" (translated by H. M. Williams, vol. 2, pp. 214-238; vol. 3, pp. 316-327). The number of lives lost was 16,000, while the first official estimate for the recent earthquake places the number at 30. Humboldt notices that, both in 1766 and 1797, swellings were observed in the shoal of Morro Roxo, near the mouth of the Rio Bordones. He traces the migration of the focus from the south coast of the Gulf of Cariaco in earlier years to Cumana in 1797, and attributes it to the opening of new underground communications, and remarks that the rapidity with which the undulations are propagated to great distances proves that the centre of action or focus—he was one of the earliest to use this term—is very remote from the surface of the globe.

ON Jan. 19 a conference was held at the John Innes Horticultural Institution, Merton Park, London, S.W., to mark the hundredth anniversary of the birth of the founder, John Innes. John Innes was a city merchant of an old Scottish family, who with his brother bought a considerable estate in Merton, and while living there proceeded to build what was then the pleasant and almost isolated suburb of Merton Park. John Innes in his lifetime gave many examples of his generosity to his neighbours, and finally left his residual property to found a school of gardening. As the endowment promised to become of considerable value, the Charity Commission, in drawing up the scheme for the administration of the trust, made provision for a research station which at the same time would train practical gardeners. The Institution thus founded began work in 1908, and, being fortunate to obtain the late William Bateson as its first director, became immediately identified with the then young study of genetics.

THE conference on Saturday last dealt with various aspects of polyploidy, as a source of species and horticultural varieties. After Mr. J. B. S. Haldane, for the benefit of the non-technical part of the audience, had explained what a polyploid was, Dr. C. C. Hurst illustrated by reference to the genus *Rosa* how cytology discriminates between species and varieties. Prof. E. W. MacBride objected that such distinctions are unknown among animals. Prof. Ruggles Gates discussed the origin of polyploids, and the variation of the size of the cells with polyploidy, but, as he and other speakers pointed out, it is difficult to make any generalisation that will cover all the cases. Dr. C. D. Darlington discussed the pairing of the chromosomes in polyploids, and Mr. J. B. S. Haldane, in explaining the laws of inheritance in polyploids, showed that their structure involves such a complexity of combinations that the chance of fixing a particular variation is greatly reduced as compared with diploids. Dr. C. L. Huskins dealt with polyploidy in cereals, where such important groups as the bread wheats and ordinary oats are hexaploids. Mr. M. B. Crane gave some remarks on polyploidy in *Prunus* and *Rubus* preparatory to a demonstration of some of the seedlings that have been raised at Merton. Miss Pellew demonstrated polyploidy in *Primula kewensis*, and Dr. F. W. Sansome some of the tetraploid tomatoes that can be produced vegetatively.

SIR WILLIAM BRAGG described recent progress in crystal analysis in his discourse delivered at the Royal Institution on Friday, Jan. 18. Discussing the use of X-rays in revealing the structure of solids, Sir William dealt with the results which have followed their application to the examination of alloys. In pure copper the atoms are piled together in close packing, like spherical shot; each sphere then touches twelve neighbours. When a small number of zinc atoms are added, they distribute themselves at random amongst the copper atoms without disarranging the pattern very much. But there is a limit to this addition. If too much zinc is put in a new pattern is formed, in which each atom now has only eight neighbours. As more zinc still is put with the copper, a very complicated pattern is formed, the unit of which is twenty-seven times as large as in the preceding case, and there are fifty-two atoms in it; this alloy is very hard and brittle. Curiously enough, there is an alloy of copper with aluminium, and again of copper with tin, in which the same properties are exhibited, the same pattern is found, and the same number of atoms in the pattern: moreover, there is the same number of free electrons. These curious alloys are composed of five atoms of copper to eight of zinc, nine of copper to four of aluminium, and the third very approximately in the ratio of thirty-one of copper to eight of tin. In each case there are thirteen atoms to twenty-one electrons. These new and interesting results are due mainly to the work of Owen and Preston, Bradley, and Bernal in England, Westgren and Phragmén in Sweden. They open up new ideas of the conditions in the alloy. They suggest that we ought not merely to think of an alloy as a mixture of atoms, but in some cases at least as a mixture of electrons with atoms, the latter having considerable latitude as to nature.

IN his presidential address, delivered on Jan. 16 to the Royal Meteorological Society, on "Amateurs as

Pioneers," Sir Richard Gregory stated that until relatively recent times all scientific societies were organisations of amateurs. At a later stage, when their inquiries became of practical value, professional institutions are established, and much of the work is taken over by industrial or national services. In the middle of last century, James Glaisher formed an organisation of voluntary observers for meteorological records, and the Royal Meteorological Society maintained this service until it was taken over by the Meteorological Office in 1912. The systematic collection of rainfall records, which was started by G. J. Symons in 1859, has similarly become part of the organised work of the Meteorological Office. The systematic study of upper air conditions, now carried on for practical purposes of aviation, originated with W. H. Dines and C. J. P. Cave. It was an amateur, Benjamin Franklin, who established the identity between the discharge from an electric machine and lightning by his famous kite experiment in 1752. An amateur also, Oliver Heaviside, first pointed out that electromagnetic waves might be reflected by a conducting layer in the upper air, now called the Heaviside layer, which makes radio communication around the world possible, and amateurs first established world communication with short waves, 300 metres or less in length. In transport also, through the experiments of Wilbur and Orville Wright, the conquest of the air has been due chiefly to the pioneer work of amateurs. Every encouragement should be given, therefore, to all such voluntary workers in scientific fields.

THE following officers were elected at the annual general meeting of the Royal Meteorological Society, held on Jan. 16:—*President:* Sir Richard Gregory; *Vice-Presidents:* Mr. R. Arniston, Lieut.-Col. E. Gold, Mr. I. D. Margary, and Mr. R. A. Watson Watt; *Treasurer:* Mr. F. Druce; *Secretaries:* Dr. C. E. P. Brooks, Commander L. G. Garbett, and Dr. A. Crichton Mitchell; *Foreign Secretary:* Mr. R. G. K. Lempfert.

THE following officers were elected at the meeting of the Royal Microscopical Society on Jan. 16:—*President:* Mr. J. E. Barnard; *Vice-Presidents:* Dr. R. S. Clay, Dr. J. A. Murray, Dr. A. S. Parkes, and Mr. E. A. Robins; *Treasurer:* Mr. Cyril F. Hill; *Secretaries:* Prof. R. Ruggles Gates and Dr. Clarence Tierney.

PROF. D'ARCY W. THOMPSON, professor of natural history in the University of St. Andrews, has been elected a corresponding member of the Société de Biologie, of Paris.

PROF. P. W. BRIDGMAN, Hollis professor of mathematics and natural philosophy at Harvard University, will deliver the Guthrie Lecture for 1929 of the Physical Society of London on April 19 next.

MR. FRANCIS P. LE BUFFE, managing editor of *Thought*, objects to a comment made in an article on "Evolution and Fundamentalism," in NATURE of Dec. 22. He did not in his article in *America* suggest "that science should be looked on askance." In a letter correcting this remark he adds, however, "I did most emphatically suggest that so-called 'scientists' and romancing scientists should 'be looked on askance.'"

MR. THOS. J. OFFER, a member of the organising committee of the scientific, optical, and photographic section in the forthcoming British Industries Fair, informs us that readers of NATURE who may be interested can obtain an invitation ticket to the Fair on application to the Department of Overseas Trade, 35 Old Queen Street, S.W.1. The scientific instrument section of the Fair has grown considerably in size and importance (see NATURE, Oct. 20, 1928, p. 631), and we hope that all scientific workers who are at hand will take the opportunity of visiting it.

ON Tuesday, Jan. 29, at 5.15, Prof. Julian S. Huxley begins a course of six lectures at the Royal Institution on evolution and the problem of species, and on Thursday, Jan. 31, Sir William Bragg gives the first of three lectures on the early history of X-rays. The Friday evening discourse on Feb. 1 will be delivered by Prof. J. L. Myres on geometrical art in south-eastern Europe and western Asia, and on Feb. 8 by Mr. C. E. R. Sherrington on recent problems of rail transport.

AT the monthly general meeting of the Zoological Society of London, held on Jan. 16, it was stated that the total number of visitors to the Society's Gardens during the past year was 2,225,662, the receipts amounting to £71,656, an increase of more than £3000 as compared with the previous year, and an increase of nearly £10,000 when compared with the average for the previous five years. The year 1928 was by far the best in the history of the Society. The visitors to the Society's Aquarium during the year numbered 444,177, the receipts amounting to £17,393, showing a decrease of £900 as compared with the previous year.

AT the autumn meeting of the Iron and Steel Institute at Bilbao, Prof. Henry Louis, formerly professor of mining and metallurgy at Armstrong College, Newcastle-on-Tyne, was unanimously nominated for election as the next president of the Institute, and he will take office at the annual meeting in London on May 2. Prof. Louis being a prominent citizen of Newcastle-upon-Tyne, the members resident in that neighbourhood considered that it would be very appropriate to hold the autumn meeting of this year in that city, and the Lord Mayor and corporation of the city have sent a cordial invitation to the Council of the Institute to hold the meeting there. The date of the meeting has been fixed for Sept. 10–12.

RECENT appointments to scientific and technical departments made by the Secretary of State for the Colonies include the following:—Mr. D. P. McGregor to be geologist in the Gold Coast, and Mr. K. R. S. Morris, assistant entomologist in the same Colony; Mr. J. D. Shepherd to be irrigation officer in the Agricultural Department, Palestine; Mr. M. Vardy to be manager, Experimental Fruit Farm, Sierra Leone; Mr. E. Messervy to be veterinary officer in Tanganyika Territory. Among the transfers and

promotions are the following:—Mr. H. M. Gardner, senior assistant conservator, to be conservator of forests, Kenya Colony; Mr. L. P. Henderson, agricultural instructor, Federated Malay States, to be superintendent, Agricultural Department, Nigeria. Mr. G. N. Sale, assistant conservator of forests, Cyprus, to be director of forests, Mauritius; Mr. D. Stevenson, deputy conservator of forests, British Honduras, to be senior assistant conservator of forests, Northern Rhodesia.

A SHORT catalogue (No. 6) of books, mainly of botanical and zoological interest, has reached us from Mr. J. H. Knowles, 92 Solon Road, S.W.2.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A full-time lecturer in electrical engineering in the Leicester College of Technology—The Registrar, College of Technology, Leicester (Jan. 31). A resident librarian at the Liverpool Medical Institution — The General Secretary, Medical Institution, Liverpool (Feb. 4). A principal of the Kirkcaldy High and Technical School—The Education Offices, Kirkcaldy (Feb. 9). A junior technical officer in the design section of an Admiralty Establishment at Portsmouth—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (Feb. 9). A research assistant in agricultural economics and a student assistant in agricultural economics in the Department of Agriculture of the University of Leeds —The Registrar, The University, Leeds (Feb. 11). An assistant in pathological chemistry in the University of Cape Town—The Secretary, Office of the High Commissioner for the Union of South Africa, South Africa House, Trafalgar Square, W.C.2 (Feb. 26). A bacteriologist in the department of agriculture of the Irish Free State—The Secretary, Civil Service Commission, 33 St. Stephen's Green, Dublin, C.2 (Mar. 19). A senior lecturer in psychology in the Rhodes University College, Grahamstown — The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (April 1). Civilian education officers in the Royal Air Force Educational Service—The Secretary, Air Ministry, Gwydyr House, Whitehall, S.W.1. An assistant master, to teach physics and mathematics, at the Guildford Junior Technical School—The Clerk to the Governors, Technical Institute, Guildford. A Government chemist for Fiji — The Private Secretary (Appointments), Colonial Office, 2 Richmond Terrace, Whitehall, S.W.1. Short-service officers in the Royal Air Force —The Secretary, Air Ministry, Kingsway, W.C.2. Aircraft apprentices in the Royal Air Force—The Royal Air Force, Gwydyr House, Whitehall, S.W.1. A junior assistant (male) under the Directorate of Radiological Research, Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18. An assistant civilian experimental officer for a Governmental Experimental Establishment—The Secretary, R.E. Board, 14 Grosvenor Gardens, S.W.1.

Our Astronomical Column.

NEW COMET: SCHWASSMANN-WACHMANN, 1929 *a*.—Prof. A. Schwassmann and Dr. A. Wachmann discovered a very remarkable comet on Nov. 15, 1927, at Bergedorf Observatory. They have now found a second comet; the following details have been communicated in a telegram from the I.A.U. Bureau, Copenhagen: Time of observation, Nov. 17^{d} 22^{h} $21{\cdot}9^{m}$ U.T.; R.A. 5^{h} 40^{m} 32^{s}; N. Decl. 20° 30′; daily motion -28^{s}, N. 3′; magnitude 11. The comet is close to the ecliptic, and was doubtless discovered, like the other one, in the course of the photography of minor planets that is carried on at Bergedorf. If the motion continues slow, there ought to be no difficulty in picking the comet up by Jan. 25, the moon being then out of the way at the beginning of the night.

RECENT SOLAR ACTIVITY.—A large group of spots crossed the sun's disc between Jan. 11 and 23. The spots were in stream formation with a large leader spot when seen on Jan. 16, but when next observed on Jan. 19, the group had altered considerably and the spots were breaking up. No magnetic disturbance was registered at Greenwich about the time of central meridian passage of the group. Besides this group there was another group, somewhat smaller, about 60° of longitude eastwards and on the other side of the equator. Particulars of position and area of the two groups are as follows:

No.	Date on Disc.	Central Meridian Passage.	Latitude.	Max. Area.
1.	Jan. 11–23	Jan. 17·4	7° N.	1/800 } of hemisphere.
2.	Jan. 16–28	Jan. 21·8	11° S.	1/1200 } of hemisphere.

Sunspot activity during 1928 was considerable. Notes on about a dozen large groups, each seen for at least two or three days as a naked-eye object, were given in NATURE at their times of occurrence. According to a report in *Jour. Brit. Astron. Assoc.* for December 1928, the mean daily area of spots for the year was about 1250 millionths of the sun's hemisphere, as compared with 1058 for 1927 and 1262 for 1926. The maximum of the present cycle is therefore not sharply defined as was that in 1917 of the preceding cycle. The curve for mean areas gives for the present cycle a double peak in 1926 and 1928, whilst the curve plotted from the average daily number of spots, irrespective of size, gives a rather indefinite maximum centring about 1927, although the top of the peak seems to have been reached in 1928. It may be anticipated that the sun's activity will show signs of a decline during 1929.

MARS.—Few results for the present apparition of Mars have yet been published; Dr. W. H. Steavenson has noted the reappearance of a broad, oblique, dark marking sloping upwards to the right, south of Pandoræ Fretum. *L'Astronomie* for December contains some beautiful drawings made at the 1926 opposition by M. E. M. Antoniadi with the 0·83 m. refractor at Meudon. There is some trace of the above oblique band shown on them. He notes that in the regions enjoying summer there is a tendency for yellowish veils, which he ascribes to clouds of fine sand raised from the desert regions, to dim the surface markings. The darker markings showed a great variety of tints; red, green, blue, violet, and brown all appear in his descriptions. Solis Lacus was green in September 1926, greenish grey in November, and brown in December. This marking appears to have expanded in the north-south direction as compared with former years.

Research Items.

EUROPEAN GYPSIES IN EGYPT.—In the *Journal of the Gypsy Lore Society*, vol. 7, ser. 3, pt. 2, Dr. John Sampson, citing a paper published by Capt. Newbold which appeared in the *Journal of the Royal Asiatic Society* in 1856, analyses a vocabulary there given of the Ghagars, one of the three gypsy tribes which the author met in Egypt. The Ghagars themselves spoke of having brethren in Hungary, but this reference had been overlooked by later writers, who had not doubted that they belonged to the eastern Romani groups, which includes the Helebis of Egypt, the Nawar of Palestine, the Kurbat of Syria and Persia, and the Karaci of Asia Minor and Transcaucasia. A re-examination of the vocabulary, however, shows close affinities with the dialects of western Romani, especially of the Balkan and eastern European gypsies, though coupled with borrowings from the eastern Romani with whom they obviously have been in contact for a considerable time. It would appear from their vocabularial and phonetic peculiarities that the Ghagars must have originated in the region of Moldavia, of which Bukowina and Bessarabia are the modern linguistic representatives. In 1322, Symon Simeonis, in his "Itinerarium," recorded the existence of a people in Alexandria and Cairo who from their characteristics were clearly gypsies who had come as prisoners of war from the Danube, and though these are probably too early in date for it to be likely that they are Ghagars, it is possible that the latter are transported prisoners of the later wars between Turk, Hungarian, and Pole in the seventeenth century.

SIGNIFICANCE OF THE MOULTING OF FEATHERS.—In a careful analysis of the succession of moults in the loggerhead shrike (*Lanius ludovicianus*) and its subspecies, Alden H. Miller finds evidence of a correlation with climatic differences (*Univ. California Pub. Zool.*, vol. 30, No. 13; 1928). The adaptive significance in the moult lies in the need for keeping the minimum level of plumage (or flight) efficiency as high as possible. In the wings and tail this end is supposedly accomplished by the alternating moults of different series of feathers, and in the remiges and rectrices, particularly, by the replacement of the least important feathers first, in order that more of the series may be new when the most important feathers are lacking. But this does not meet all the case. The facts that the long central pair of rectrices and the largest of the inner secondaries drop first, and that the alula and outer primaries are lacking at the same time, are not easily explained on the same basis. The author reaches the conclusion, therefore, that although all phases of moult order must be adjusted at least to the extent that the birds are able to survive, there is still to be seen in the moult behaviour of certain feathers, in addition to adaptation, a definite reflection of either embryonic or phylogenetic homologies, or perhaps both. The extent to which all these factors enter in various degree into the moults of different subspecies can only be elucidated by further investigation of the phenomena in this and other species.

AN AMERICAN GENUS OF LIZARDS.—Knowledge regarding the genus *Ctenosaura*, a series of large tree and rock lizards, some of which may exceed three feet in length, has been unsatisfactory, and the extent of the unsatisfactoriness may be gathered from John Wendell Bailey's "Revision," in which the 27 reputed species have dwindled under critical examination by more than 50 per cent (*Proc. U.S. Nat. Mus.*, vol. 73, art. 12, 1928). The thirteen recognised species are confined to Mexico and Central America, and the most widely distributed, and at the same time the most primitive species, happens to be that first described in 1802. The new analysis shows that it is impossible to distinguish *Ctenosaura* from allied genera by any structure of skeleton, and reliance has been placed upon the usual external characters. Indefiniteness also shrouds the geological history of the genus, but it would appear to be closely related to, and to have been derived from, a common iguanid stock, from the headquarters of which in central western Mexico it spread in even waves north and south. At the present day, the transition in morphological characters from this centre of distribution is a gradual one, without any break in the series. These lizards are active and powerful, and are able to inflict nasty wounds by the use of their small sharp teeth, and by the lashing of their spiny tails.

SOME INDIAN FISHES.—Dr. Sunder Lal Hora and Mr. D. D. Mukerji give a detailed survey of the genus *Esomus* ("Notes on Fishes in the Indian Museum, XVI. On Fishes of the Genus *Esomus*. Swainson," *Records of the Indian Museum*, vol. 30, pt. 1, 1928). These are small cyprinid fishes with elongated and strongly laterally compressed body, and amongst other characters, with two pairs of barbels at the corners of the mouth, one pair short and the other pair very long, sometimes extending as far back as the base of the anal fin. These barbels give the fishes a peculiar and distinctive appearance. The genus occurs in British India, Ceylon, Nicobars, Malay Peninsula, Malay Archipelago, and French Indo-China. The authors have reduced the Indian species, of which there were a number, to five. *Esomus danicus* is the commonest, inhabiting ponds and ditches; *E. altus* is a Burmese species, a fine series of which was purchased by Dr. Annandale from the Mandalay market; probably the commonest species in Ceylon is *E. thermoicus*, originally described from the hot springs in Kanniya, but apparently no longer to be found in them. In the same volume of the *Records* the senior author describes a new species of *Brachydanio* and gives a few notes on other Burmese fishes ("Notes on Fishes in the Indian Museum. XV."). In part 2 Mr. J. R. Norman continues his report on the Indian Heterostomata ("The Flatfishes (Heterostomata) of India, with a List of the Specimens in the Indian Museum," part 2), the first part having appeared in the previous volume. The families Soleidæ and Cynoglossidæ are now dealt with. There are eight genera of the Soleidæ in Indian waters and three of the Cynoglossidæ, by far the larger number of these last belonging to *Cynoglossus*. Plates representing four of the Soleidæ show the striking form of *Brachirus macrolepis* and three species of *Zebrias* with their wonderful transverse markings from which the genus is named.

BRYOZOA OF THE AUSTRALIAN-ANTARCTIC EXPEDITION.—Mr. Arthur A. Livingstone, assistant zoologist in the Australian Museum, Sydney, gives a detailed supplementary report on the Bryozoa of the Australian Antarctic Expedition, 1911–14 (*Scientific Reports*, Series C, Zoology and Botany, vol. 8, Part 4, 1928). The first report was made by Miss L. R. Thornely and published in New South Wales by the Australasian Antarctic Publication Committee (Series C, 6, 6, Polyzoa, 1924). It was found, however, that the material sent to Miss Thornely was not complete, as a large portion of it had been overlooked. Hence the present volume, in which the original classification and many of the identifications have been considerably

altered. Two of Miss Thornely's new species have been placed in new genera: *Cellaria membranacea* in the new genus *Mawsonia*, *Aspidostoma obliquum* in the new genus *Pseudocellaria*. *Membranipora elongata* Thornely is shown to be *Ogivalana lata* (Kluge), and this forms only the second record from the Antarctic, Kluge's original description being here supplemented by further notes. The paper is illustrated by beautiful photomicrographs by Mr. G. C. Clutton and by clear diagrammatic text figures by the author.

THE PLANT WALL IN THE LIGHT OF DIGESTION EXPERIMENTS.—Max Rubner gives, in *Die Naturwissenschaften* for Nov. 30, 1928, a general account of the physiological significance of the main components (pentosans, celluloses, and lignins) of the plant wall from the point of view of digestion experiments that were carried out in Germany during the War and the immediate post-War period. From this account, several conclusions of general interest emerge. In experiments upon animals and upon man, there was often a remarkable difference in the degree of digestion of cellulose material from the same foodstuff in different experiments upon the same subjects. Some of this difference may be due to difference in the bacterial flora of the intestinal tract, but the differences are so marked that Rubner concludes they point to the existence of many different forms of cellulose. As the same differences appeared when the purified celluloses from these food products are fed to animals, it does not seem possible to attribute them to the different extent to which the plant membrane is impregnated with fatty substances or lignins. Rubner discusses the wide variations in the methods used by different investigators to separate the lignin from the plant membrane, with the result that very different substances are probably included under this name. In any case it appears from the analysis of pentosans, cellulose, and lignin in a vegetable food material, before and after its passage through the mammalian alimentary canal, that in many cases a certain amount of the lignin fraction must undergo digestion. Whilst it is probably true that heavy lignification is associated with relative indigestibility, it would not seem safe to assume that the only constituent of a lignified plant wall to undergo digestion is any inner lining of pentosan character that may be present.

NITROGEN CYCLE IN THE SOIL.—Carsten Olsen (*Comptes rendus du Laboratoire Carlsberg*), working on the significance of the hydrogen-ion concentration for the cycle of nitrogen transformation in the soil, has determined that ammonification can proceed in soils with pH values between 3·7 and 9·0, the process being most active when this value lies between 7·0 and 8·5. Nitrification can proceed in soils with pH between 3·7 to 8·8, the optimum being at pH 8·3 in soils rich in ammonia. Under natural conditions, in soils with pH between 4·0 and 8·0, the rapidity of nitrification is determined by the rate of ammonification, as the latter process limits the former. In strongly acid soil which is rendered alkaline by the addition of calcium carbonate, there takes place very rapidly a powerful nitrification unless it is necessary to add inoculating soil from an alkaline reacting soil. Provided the nitrifying bacteria working in the acid soil are special kinds which cannot work in alkaline soil, the bacteria working in the alkaline soil must either be found in small quantities in the originally acid soil or be introduced in dust. The latter suggestions seem quite feasible, as the nitrifying organisms are not killed when soil containing them is dried out at ordinary room temperature, and transportation as dust from one locality to another is therefore possible.

CLASSIFICATION OF OCEANS AND SEAS.—Oceanographers have made several attempts to find a satisfactory classification of oceans and seas, but no general agreement has yet been reached. M. C. Vallaux has an article on this subject in *La Géographie* for September–October 1928 (vol. 50, Nos. 3-4). He develops the idea that most classifications take too much account of the arbitrary divisions of the waters that are the outcome of practical use, and thus in consequence the important physical considerations tend to be lost to sight. The classification M. Vallaux suggests is a simple one. He recognises four oceans, Southern, Pacific, Indian and Atlantic. The Southern Ocean has climatic limits, lat. 35° S. and the Antarctic Circle. The others have mainly topographical boundaries, except that the Atlantic Ocean ends at the Arctic Circle in the north-east. Seas are divided into four groups. Icy seas (*mers glacées*) are the Arctic sea and the marginal Antarctic seas. Garland seas (*mers guirlandes insulaires*) include the Bering, Okhotsk, Japan, China, and Andaman Seas. Mediterranean seas, which generally have deep basins, mark lines of instability in the earth's crust. Lastly, shallow seas include the Persian Gulf, the Baltic, Hudson Bay, the Gulf of St. Lawrence, the North Sea, the English Channel, and the Irish Sea. According to M. Vallaux, calculations gives the areas of the oceans in millions of square kilometres as follows: Southern, 85·5; Pacific, 126·9; Indian, 42·4; and Atlantic, 58·2. The areas of seas are also given in the paper.

NEW PENDULUM APPARATUS FOR GRAVITY WORK.—Interesting and important advances in pendulum apparatus for the determination of gravity are embodied in the new Cambridge apparatus described by Sir Gerald Lenox-Conyngham, its inventor, at the Royal Geographical Society meeting of Jan. 14. The instrument is made by the Cambridge Instrument Company, Ltd., and many of its parts were specially designed by the late Sir Horace Darwin. The object aimed at was the determination of the time of swing to 2×10^{-7} second, when the time is reduced to its estimated value under ideal conditions, that is, *in vacuo*, at standard temperature, with an infinitesimal arc of vibration, and in a perfectly steady and rigid stand. In the Cambridge apparatus, an airtight chamber is used and the pressure is reduced to between 60 mm. and 80 mm. of mercury, the value being easily measured and controlled, while the pressure constant is well determined. The rods which start or lift and lower the pendulums pass through stuffing-boxes which possess an oil seal. The pendulums are made of nickel-steel, of the same composition as invar, and the temperature correction is small and well-determined. Provision is made for measuring the arc of swing, in order to allow for it. In order to prevent the motion of the pendulum from setting its case and stand in vibration, two pendulums, carefully adjusted to the same period, and swinging in opposite phase in the same plane, are used. In order to eliminate any influence of movements of the pillar on which the apparatus may be placed, use is made of the device of Vening Meinesz, in which a third stationary pendulum of similar construction, and able to swing in the same plane, is placed between the two pendulums. The optical arrangements for observing the motion of the pendulums are ingenious, and are described in detail in the account which is to appear in the *Geographical Journal*.

A NEW METHOD FOR INVESTIGATING γ-RAYS.—A method for finding the direction of hard γ-rays which does not require the delineation of a pencil by screens has been devised by W. Bothe and W. Kolhörster.

It employs instead the fact that secondary electrons which have been set free by waves of very high frequency move off from their parent atoms approximately in the direction of the radiation. The trajectory of the electrons can be found by setting a pair of Geiger electron counters in various positions until they show a maximum number of coincident discharges due to the individual electrons affecting each in turn, when their common axis must be in the line of the incident γ-rays. So far, the authors have only published a short preliminary account of their method (*Die Naturwissenschaften*, Dec. 7), but it has an obvious application to the problem of the origin of the cosmic rays, which can be particularly well studied by means of it because of their extremely short wave-lengths. They mention that when relatively soft rays are excluded by a filter of 10 cm. of lead, the number of coincident discharges of the counters which cannot be ascribed to the presence of radioactive substances is increased threefold by rotation of the detecting system from the horizontal to the vertical.

ELECTRIC HEATING AND VENTILATION.—Most of the problems connected with the electrical heating of rooms have now been satisfactorily solved. A problem which deserves more careful consideration, however, is that of the ventilation of electrically heated rooms, especially when they have no chimney or when, as is usually the case, the chimney has been bricked up. In the case of large shops, where there are crowds of customers, the difficulties to be overcome are many. Messrs. Bourne and Hollingsworth, Ltd., of Oxford Street, London, are to be congratulated on the arrangements they have made for heating, ventilating, and cooling their departments. A full account of the arrangements made is given in the *Electrical Review* for Jan. 11. Provision has been made with the Marylebone Corporation for a supply of 3500 kilowatts. The installation is probably the largest of its kind in the world. The floor space is 160,000 square feet and the volume of the air is two million cubic feet. The air is maintained at an average temperature of 62° F. throughout all the rooms and floors served. It is also renewed seven times every hour. The operating principle employed is that of blowing hot or cold air by means of fans into the various departments. The temperature and volume of the air admitted is regulated from a central control room. From this room all the motors, fans, heaters, and dampers are controlled by switches. The temperatures registered at fifty appropriate places are indicated in the control room and four records can be taken simultaneously. It is claimed that the temperature of the entire building can be maintained within one degree Fahrenheit no matter how the outside temperature and the number of persons in the building vary. This scheme was adopted as the estimates showed that it was cheaper than any of the others proposed.

ROWLAND'S WAVE-LENGTH AND TABLES.—For just over thirty years, Rowland's "Preliminary Table of Solar Spectrum Wave-lengths" has provided the world with a valuable standard of reference. But since it was published our standard of accuracy has risen, a new system of laboratory standards has been developed and adopted, and the time has come for the "Revision of Rowland's Preliminary Table of Solar Spectrum Wave-length," with an extension to the present limit of the infra-red (10,218 I. A.). For this most valuable work we have once more to thank the United States, and in particular Dr. C. E. St. John and his colleagues. In their identifications of the lines they have many physical considerations unknown in Rowland's day to help them towards their decisions; in particular, the knowledge of the excitation potential required to raise the atom from its lowest energy state to the state in which it can absorb a given line is now very frequently known and also the groups of lines which should occur together. Only one criticism need be made of the necessary economy in printing and choice of data to be given. In Table VI. the designations for excitation potentials corresponding to the higher terms involved in any transition might have been added. This would have enabled a student to give the complete multiplet designation of any line in which he was interested without reference to the source used in preparing the main table. The list of references to these sources is not the least valuable part of the volume. We may note that 57 elements have been identified in the sun, and 32 of these as ionised elements also. No evidence of double ionisation has been found. Of the 35 elements not identified definitely, 18 are doubtfully possible of detection. Only 175 lines of intensity 2 or higher remain unidentified. The work is a fine performance, and it is in its favour that it must leave the reader with an even higher opinion of the value and accuracy of Rowland's original table than he had before.

CONTACT CATALYSIS.—The National Research Council of the U.S.A. has recently published the Sixth Report of the Committee on Contact Catalysis, by R. E. Burk, in collaboration with other members of the committee (*Reprint and Circular Series of the National Research Council*, No. 83 (Washington, D.C.: National Academy of Sciences)). The report first appeared in the *Journal of Physical Chemistry*, vol. 22, 1928, p. 1601. In addition to covering new developments, the present report summarises the five previous reports, and an attempt has been made to include relevant work in other fields.

ALKYL ORTHOSILICATES.—The *Journal of the American Chemical Society* for November contains an account by A. W. Dearing and E. E. Reid of an improved method for the preparation of ethyl orthosilicate and the synthesis of a number of new orthosilicate esters. The ethyl orthosilicate has been converted into silica gel by the addition of the calculated amount of water together with 1·5 times its volume of alcohol. This gel, which was free from strong electrolytes, showed the same absorption as ordinary silica gel obtained from sodium silicate, but had a greater catalytic activity. A non-aqueous gel was prepared by refluxing the ester with acetic acid, excess of which was removed by dry benzene.

THE DISCOVERY OF ETHER.—The discovery of diethyl ether is usually attributed to Valerius Cordus (1515–1544). In an article in the *Journal für praktische Chemie* (Bd. 120, 74-88; 1928), Dr. Ernst Darmstaedter critically considers Cordus's account of the preparation of *oleum vitrioli dulce* and reaches some very interesting conclusions. He shows that Cordus first mixed fuming sulphuric acid with alcohol and allowed the mixture to stand for one or two months. At the end of this time the liquid was placed in a distillation apparatus and gently heated "until the alcohol originally added" was removed. The temperature was then raised and the distillate collected. This consisted of two layers, namely, water and the 'sweet oil of vitriol' assumed by later writers to have been ether. Darmstaedter points out that the properties of the oil as described by Cordus do not agree with those of ether, and demonstrates conclusively that the *oleum vitrioli dulce* must have been diethyl sulphate. He believes that Cordus probably never once suspected the existence of the very volatile ether. Cordus mentions that only a small yield is obtained, a statement in agreement with modern observations (Villiers, 1903, says that 200 grams of ethyl alcohol yield only 30 grams of diethyl sulphate).

Annual Prize Awards of the Paris Academy of Sciences.

AT the annual public meeting of the Paris Academy of Sciences on Dec. 17, the prizes and grants awarded in 1928 were announced as follows :

Mathematics.—The Poncelet prize to Gaston Julia for the whole of his mathematical work ; the Francœur prize to Szolem Mandelbrojt for his work in mathematical analysis.

Mechanics.—The Montyon prize to Filippo Burzio for his work in ballistics ; the Henri de Parville prize to F. C. Haus for his researches in aeronautics.

Astronomy.—The Lalande prize to Bernard Lyot for his work on the polarisation of the planets ; the Valz prize to Georges van Biesbroeck for the whole of his astronomical work ; the Janssen medal to William Wright for the whole of his work.

Geography.—The Delalande-Guérineau prize to Paul Serre for his scientific collections during the last thirty years ; the Gay prize to Henri Gaussen for his contributions to the study of the flora, climate, and geology of the eastern Pyrenees ; the Tchihatchef foundation to Eugène Poilane for his botanical and entomological collections in Indo-China ; the Binoux prize (in equal parts) between Carlos Ibañez de Ibero for his work in connexion with the proposed tunnel under the straits of Gibraltar, and the late Paul Soulier for his work on the origin and evolution of the earth's relief.

Navigation.—The prize of six thousand francs to Dieudonné Costes and Joseph Marie le Brix for their remarkable flight ; the Plumey prize to Albert Thuloup for his memoir on the fatigue of thin pipes.

Physics.—The L. Lacaze prize to Charles Mauguin for the whole of his work in crystallography ; the Kastner-Boursault prize to Pierre Auger for his work on the structure of the atom ; the Hébert prize to Jean Granier for his book on electrical measurements ; the Hughes prize to Jean Thibaud for his work on the X-rays ; the Danton foundation to Pierre Bricout for enabling him to continue his researches on the measurement of radiation ; the Clément Félix foundation to Paul Woog for the continuation of his work on oiliness.

Chemistry.—The Montyon prize (unhealthy trades) to Mme. Mélanie Rosenblatt, for her work on the study of poison gas and of the means of protection against it ; the Jecker prize to Victor Auger for the whole of his work ; the L. La Caze prize to Paul Pascal for his work in pure and applied chemistry ; the Cahours foundation to Mme. N. Demassieux for her physicochemical work ; the Houzeau prize to Albert Portevin for his work in metallurgy.

Mineralogy and Geology.—The Victor Raulin prize to Jean Orcel for his work on the chlorites ; the James Hall prize to Jean Piveteau for his memoir on the Permian of southern Madagascar and its quadruped vertebrate fauna.

Botany.—The Desmazières prize to Léonidas Grigoraki for his work on parasitic fungi ; the Montagne prize to Roger Werner for his memoir on biological and experimental researches on the ascomycetes of lichens ; the de Coincy prize to Mlle. Gabrielle Bonne for her memoir on the pedicel and flower of the Rosaceæ. An honorable mention to (the late) Eugène Perrier de la Bathie.

Anatomy and Zoology.—The Cuvier prize to Louis Boutan for the whole of his zoological work ; the Savigny prize to J. L. Dantan for his study of the plankton flora of the bay of Algiers and other biological work ; the Jean Thore prize to Étienne Hubault for his work entitled " Contribution à l'étude des Invertébrés torrenticoles."

Medicine and Surgery.—Montyon prizes to Maurice Chiray and Ion Pavel (2500 francs) for their work on the gall-bladder ; Edmond Papin (2500 francs) for his book on the surgery of the kidney ; Gustave Worms (2500 francs) for his memoir on the pathological anatomy of the thymus. Honourable mentions (1500 francs) to Albert Berthelot, to Gaston Ramon, and to Mlle. Germaine Amoureux for their biochemical researches on the toxins and their derivatives ; to Charles Foix and Julien Marie for their work entitled " La sclérose cérébrale centro-lobaire à tendance symétrique, ses rapports avec l'encéphalite périaxale diffuse " ; to Édouard Schoull and Louis Weiller for their work on the use of creosote in the treatment of pneumococcus. Citations to Pierre Dombray, Charles Lombard, Jean Nicolaïdi, and to A. W. Turner and J. Davesne. The Barbier prize to Joseph Belot and François Lepennetier for their memoir on the radiographic anatomy of the normal skeleton ; the Bréant prize between Georges Blanc (3000 francs) for his experimental researches on herpes, and Édouard Rist (2000 francs) for his work on tuberculosis ; the Godard prize to Paul Bordas for his studies on the kidney and surrounding tissues ; the Bellion prize to Noël Fiessinger and Henry Walter for their work on the functional exploration of the liver and hepatic insufficiency ; the Larrey prize to Antony Rodiet and Fribourg-Blanc for their work on mental troubles and the War of 1914–1918.

Physiology.—The Montyon prize to Maurice Rose for his work on phototropism and on plankton ; the La Caze prize to Louis Lapicque for the whole of his work in physiology ; the Pourat prize to Robert Courrier for his work on the determinism of secondary sexual characters ; the Martin-Damourette prize to Eugène Jamot for his researches on the treatment of sleeping sickness ; the Philipeaux prize to François Granet for his work on the pseudobranch of fish.

Statistics.—The Montyon prize to Georges Darmois for his memoir on mathematical statistics.

History and Philosophy of Science.—The Binoux prize to André Metz for his work entitled " Une nouvelle philosophie des sciences : Le causalisme de M. Émile Meyerson " ; the Henri de Parville prize (2500 francs) to Alfred Chapuis and Édouard Gélis for their book " Monde des automates, étude historique et technique " ; also prizes (1000 francs each) for the books " Science et travail : Grande encyclopédie illustrée des nouvelles inventions " (editor J. L. Breton) and " Microbiologia aquaria e tecnica," by Gino de Rossi.

Medals.—Berthelot medals to Mme. Mélanie Rosenblatt, Victor Auger, and Albert Portevin.

General Prizes.—The prize founded by the State (Grand Prize of the mathematical sciences) to Georges Giraud for his work on partial differential equations ; the Bordin prize to Louis Fage for his zoological work ; the Lallemand prize to Mlle. Fernande Coupin for her work on anthropoid apes ; the Vaillant prize to Maurice Frechet for his work on abstract ensembles ; the Estrade-Delcros prize to Pierre Jolibois for his chemical work ; the Houllevigue prize between Paul Danguy for his researches on the flora of Madagascar and of Siberia, and Mme. Yvonne Gubler-Wahl for her work on the geological survey of France ; the Saintour prize to Émile Terroine for his researches on the physiology of nutrition ; the Lonchampt prize to Maurice Javillier for the continuation of his work on the mineral composition of plants ; the Wilde prize to Albert Pérard for his work in metrology and physical optics ; the Caméré prize to Louis Biette for his book entitled " Les chemins de fer urbains parisiens " ; the Roux prize to François Divisia for his memoir on rational economics ; the Thorlet prize to Adolphe

Richard; the Albert 1st of Monaco prize to A. Cotton for the continuation of his researches on powerful magnetic fields.

Special Foundations.—The Lannelongue foundation between Mmes. Cusco and Rück; the Helbronner-Fould prize to Mme. Marcel Bertrand for assisting the publication of the collected researches of the late M. Bertrand.

Prizes of the Grandes Écoles.—The Laplace prize to Pierre Robert; the L. E. Rivot prize between Pierre Robert, Alphonse Grange, Roger Dodu, and Marcel Davin.

Foundations for Scientific Research.—The Trémont foundation to André Charrueau for his researches on the equilibria of fluids; the Gegner foundation to Maurice Vèzes for his treatise on physical chemistry; the Jérome Ponti foundation to Pierre Cappe de Baillon for his researches on the teratology of insects; the Hirn foundation to Maurice Gevrey for his work on partial differential equations; the Henri Becquerel foundation to Paul Lévy for his works on functional analysis.

THE LOUTREUIL FOUNDATION.

The Academy received 31 requests for grants from this foundation, 25 of which were acceded to as follows:

National Museum of Natural History, 11,000 francs for the establishment of a catalogue of the books in the laboratory libraries: 12,000 francs to the École Polytechnique for the use of the library; 2000 francs to M. Nicolas, director of the National Veterinary School of Alfort, for his biochemical researches on thiourea and its derivatives; 4000 francs to M. Maignon for continuing his researches, especially on the influence of the seasons and of the genital glands on basal metabolism and the specific dynamic action of foods in the dog; 4000 francs to the National Veterinary School of Lyons for the completion of sets of foreign periodicals in the library; 4000 francs to the National Veterinary School of Toulouse for additions to its library; 4000 francs to the National Agronomic Institute for the completion of sets of periodicals in its library interrupted by the War; 3000 francs to Paul Nottin for his researches on the saccharification of starch.

Conservatoire national des Arts et Métiers.—5000 francs to Léon Guillet for the purchase of material for researches on the action of repeated stresses on metals and for the development of installations for thermal treatment; 4000 francs to the library for the purchase of books.

Grants other than to Institutions.—5000 francs to René Jeannel for the publication of parts 57 to 59 of the zoological studies undertaken on material collected in the course of the expedition made by him (with M. Alluaud) in Central Africa; 5000 francs to Louis Bazy for his researches on the curative and preventative properties of the bacillus of paratuberculous enteritis of cattle and of its extracts; 5000 francs to Mme. Delage as the last contribution to the publication of the last volume of the biological annual; 1000 francs to Édouard Doublet for the publication of a historical work on Gustave Lambert; 2000 francs to Henri Douvillé for the research in the field of fossils permitting the completion of the study of the Rudist limestones of the Pyrenees; 5000 francs to the "Faune des Colonies françaises"; 2000 francs to Gaston Fayet to ensure the regular publication of the *Bulletin* of the Nice Observatory; 5000 francs for the publication of material collected by the cruises of the *Travailleur* and the *Talisman*; 6000 francs to Henri Humbert to contribute to his studies of the flora of the high mountains of Madagascar and its comparison with that of tropical Africa; 3000 francs to the Institut d'Optique for the purchase of books to complete its library; 8000 francs to Jean Mascart to contribute towards the cost of printing observations of work carried out or centralised at Lyons; 5000 francs to the Paris Observatory for completing the publication of Lalande's catalogue; 8000 francs to the Zo-Se Observatory to assist in the publication of observations made at this Observatory; 4000 francs to Jean Piveteau to undertake geological and palæontological researches in southern Tunis; 8000 francs to J. Risbec for the purchase of apparatus to enable him to carry on his biological researches in New Caledonia.

The Mme. Victor Noury foundation between Fernand Blondel (4000 francs) for his work on the geology of Indo-China, René Fortrat (3000 francs) for his work on spectroscopy, and Lucien Klotz (3000 francs) for his work in connexion with the rights of authors and scientific men and the protection of scientific property; the Bouchard foundation to Constantin Toumanoff for the continuation of his researches on the normal and pathological (microbial diseases) physiology of insects; the Ray-Vaucouloux foundation to Claudius Regaud for the whole of his work on the action of radium and of the X-rays on normal and on pathological tissues, with special reference to the use of the radiations in the treatment of various cancerous growths.

Annual Meeting of the Mathematical Association.

"WHERE you find a low standard of education, there you find with it dark superstition and enslavement to formulæ in every aspect of life." No reader of NATURE is likely to quarrel with this statement (liberally misquoted from memory) with which Mr. N. J. Chignell began his paper on "The Use and Abuse of Formulæ" at the annual meeting of the Mathematical Association on Jan. 7 and 8. Happiest among his examples of the general formulæ that are being questioned by a world awaking to thought, before he came to those which belong distinctively to mathematics or science, was this: "That a cloth cap must always be taken off in the presence of a top-hat." Not many years ago, the ensuing discussion would certainly have brought to light some of our dear old friends with their final argument that "memorising formulæ gets boys through who are too stupid to pass in any other way." These are not extinct; but "the sun ariseth and they get them away together, and lay them down in their dens." Even the examiner, formerly the arch-enemy, looks now for understanding rather than memory, so Prof. Neville told us: there is much that the examiner can do to help, by forbidding the use of unproved formulæ or by setting a question to which no 'crammable' formulæ apply.

One of the quaintest of our modern superstitions is that the common methods of voting give us the representatives we want. A singularly interesting paper by Prof. J. E. A. Steggall, illustrated by numerous examples from his own experience at Dundee, showed how remarkably effective they can be in giving us just those representatives whom the majority decidedly prefer to do without. When two prizes for valour were to be awarded after the battle of Salamis, it is recorded that the commander of the contingent from every Greek state modestly recommended himself for the first prize and Themistocles for the second: the system of counting first places only would have left the greatest soldier of his time at the foot of the poll. Nearer home than that, it is no uncommon thing for A to be elected out of three candidates on

'first-choice' votes alone, when actually a majority prefers B to A, and at the same time C is also preferred to A by a majority of the voters. The impact of mathematical thought upon human affairs lags far behind the work of chemistry, electricity and psychology in making a world for man to live in: this matter of elections of various kinds is conspicuously one in which the mathematician should feel his responsibility for making to the national thought that contribution for which his gifts and training fit him.

Proportional representation, a plan lying outside the limits which time set to Prof. Steggall's discussion, deserves from mathematicians (and others) far more notice than it has yet received; but this is distinctively a method of electing two or more: it has nothing to tell us about the best way to pick out from a number of candidates the one who is preferred to the others individually by the largest majorities of the voters. If twenty such candidates compete for one place, we should regard the contest as 190 duels between one candidate and another: it is surprisingly easy, both for voter and for counter, so to arrange the election that the algebraic sum of every candidate's majorities in his 19 contests emerges directly from a single ballot.

It is safe to forecast that for some centuries to come "Modern Mathematical Problems in Aerodynamics" will be a fruitful meeting-ground for science and mathematics. Prof. H. Levy's researches into the vortex motion set up in the air by the passage through it of an aeroplane's wing deserves something better than the comments of one ignorant of aerodynamics: therefore let it pass unsung, but not unhonoured.

"Should a candidate for School Certificate be allowed to take, in place of the Mathematics and Science Group, a Group containing Drawing and Music and possibly other subjects?" This was the principal subject for general discussion—a somewhat one-sided discussion, because, though on details there was as much divergence of opinion as one would expect, there was but little opposition to the general principle involved, that children well gifted and well taught in subjects of three different kinds should not be classified as educational failures because of weakness in a fourth. Music, drawing, and handicraft constitute a group at present generally inferior for certificate-winning purposes to the other three, which are English subjects, languages, and the science-mathematics group.

This arrangement finds few defenders: some of its opponents are for republican equality between all groups, others for supremacy of one only, the English group. A powerful advocate of this supremacy was Mr. F. H. Knight, who boldly claimed for English subjects the place of honour as most of all a means of access to 'the things of the spirit,' without which other learning will not save the world. Mr. Knight also stressed the educational value of handicraft, not only as being for many children the only form in which solid geometry can be digested, but also for its influence on the development of mind on a wider scale than the mere book-learner can ever appreciate.

Science and mathematics are strong enough to stand on their own merits without needing to entrench their position by decrying the value of other subjects. Generosity, justice, and common sense would alike have been outraged if the Mathematical Association had denied that to the artist his subject is of no less value than is ours to us. Best of all, Demetrius the silversmith was conspicuous by his absence, "which made silver shrines for Diana," and whose trump-card against a rival to his goddess was that "by this craft we have our wealth." W. HOPE-JONES.

The Circulation of Seismological Information by Wireless Telegraphy.

IN a recent issue of NATURE (Dec. 22, p. 968) a short account was given of the existing arrangements for broadcasting early information concerning important earthquakes, and it was announced that the co-operation of American seismological stations would commence this month.

The large earthquake which occurred on Jan. 13 afforded an interesting test of the scheme, and it is satisfactory to record that data from all stations issuing broadcast seismological messages were picked up by the Air Ministry and communicated to Kew Observatory. An early knowledge of the position of the epicentre and of the time of origin was thus obtained. The following table summarises the information received at Kew:

Station.	Arrival of P, G.M.T.	Interval $(S-P)$.	Distance of Epicentre Δ	Azimuth of Epicentre (from N. through E).	Time of origin deduced from $(S-P)$ using B.A. tables.
	h. m. s.	m. s.	Km		h. m. s.
Kew	0 14 49	9 34	8290	19°	0 3 4
Helwan	0 15 41	10 9	8970	..	0 3 17
Bombay	0 14 12	9 0	7600	..	0 3 5
Stonyhurst[1]	0 14 39	9 21	7850	..	0 3 8
Georgetown	0 15 14	9 51	8620	330° ± 5°	0 3 9
Honolulu	0 11 32	6 50	5150	330° ± 5°	0 2 50
Strasbourg	0 14 54	9 39	8380	..	0 3 3

[1] The Stonyhurst figures were not broadcast, but were received by post.

The agreement between the figures in the last column is satisfactory, and for a preliminary value of the time of origin we may accept 0 h. 3 m. 6 s. G.M.T.

The accompanying diagram (Fig. 1) is taken from

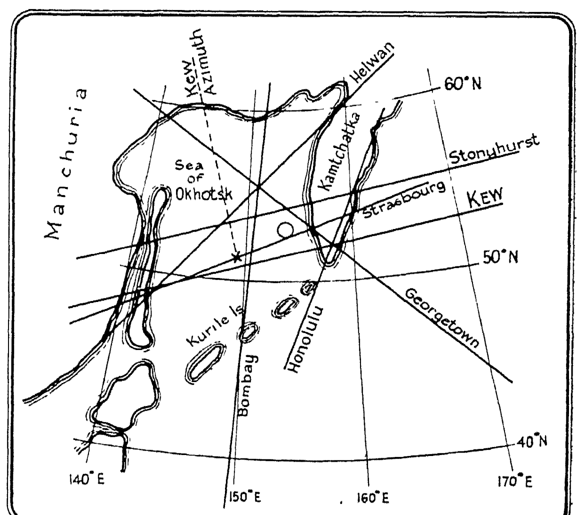

FIG. 1.

the globe on which the epicentral distances were marked off; the arcs in the neighbourhood of the epicentre are shown. From the intersections the epicentre is estimated to have been approximately at the point which is marked with a circle; that is, 53° N., 153° E., in the Sea of Okhotsk near the western coast of Kamtchatka. The initial impulse registered by the Kew seismographs (3 components) was sufficiently large to give a trustworthy estimate of the

bearing, which, together with the epicentral distance, gives 50° N., 150° E., for the co-ordinates of the epicentre. This determination is marked by a cross on the diagram. The agreement with the result obtained by using data for the seven stations is as good as could be wished.

The earthquake occurred in a region where such occurrences are frequent. There were considerable earthquakes there on Feb. 16 and Dec. 28, 1927.

University and Educational Intelligence.

Birmingham.—Mr. R. G. MacGregor has been appointed lecturer in physiology.

The University Appointments Board has issued its fourth annual report. The report shows a marked increase in the number of new graduates registered, and in the number for whom employment has been found. The demand for men and women with a university training appears to be definitely on the increase, particularly in commerce and industry. It is noted that, of a total of 45 vacancies notified for civil engineers, 44 were for posts abroad. A significant fact is that, of the 64 registered graduates who are unemployed, 50 are seeking appointments in the teaching profession.

Cambridge.—The official letter conveying the offer of the International Education Board of £700,000 on condition that within a few years the University finds a further £229,000, in addition to the £250,000 already secured for the new Library, has now been received and published. It deals most generously and helpfully with many minor points in connexion with the University, but there is a stipulation that no legacies shall be contributed towards the supplementary sum to be provided by the University, a stipulation not without interest to the University at the moment.

Three further benefactions are announced. A very valuable collection of medical, engineering, electrical, and optical apparatus, bequeathed to the University by the late Sir David Goldsmid-Stern-Salomons, Gonville and Caius College, subject to the life interest of his widow, has now been offered by Lady Salomons to the University. The late Dr. J. W. L. Glaisher, Trinity College, has bequeathed his mathematical books to the University Library, and his collection of china and pottery and other works of art to the Fitzwilliam Museum, with a sum of £10,000 to be applied in making provision for the care, preservation, and exhibition of the collection. Messrs. Bernard, Reginald, and Kenneth Pretty have offered to the University, at the wish of the late Miss Gwynaeth Pretty, Girton College, her residuary estate of the approximate value of £5000 for the furtherance of research for the prevention of disease. The diseases in which the testatrix was most interested were those that cripple or disable in childhood.

Dr. R. A. McCance, Sidney Sussex College, has been appointed to the Pinsent-Darwin Studentship in mental pathology.

The Ella Sachs Plotz Foundation is at present assisting research on problems in medicine or surgery, especially group researches on a single problem; for example, for the past five years the general subject of nephritis, and to a lesser extent internal secretion and infection, have been given special consideration. Twenty-one grants were made during 1928, of which thirteen were to workers outside the United States. Applications for grants to be held during 1929–30 must reach the secretary of the executive committee, Dr. Joseph C. Aub, Huntington Memorial Hospital, 695 Huntington Avenue, Boston, Mass., before May 15.

Calendar of Patent Records.

January 27, 1778.—One of the many improvements in the water-closet was due to Joseph Bramah, who was granted a patent for his 'valve' closet on Jan. 27, 1778. Bramah's was not only the pioneer in this type of closet, but it also remained superior in its action to all the many inventions in the same class that followed it. The modern water-closet was first described by Sir John Harington in his "Metamorphosis of Ajax," published in 1596, many years before it came into general use.

January 28, 1589.—The saltpetre monopolies of Elizabeth and James I. are notorious from the fact that it was partly the abuse of their privileges by the saltpetre men appointed by the various patentees that led to the popular agitation against monopolies and ultimately to the Statute of Monopolies of 1623, but there was at the time a clear case for the establishment of a national source of supply for the manufacture of gunpowder. One of these patents was that granted to George Evelyn, Richard Hills, and John Evelyn on Jan. 28, 1589. Certain districts, notably London, being already covered by other grants, were excluded from its operation, but in 1591 a new grant was issued to the Evelyns that gave them a virtual monopoly. George Evelyn was the grandfather, and John Evelyn the uncle, of the diarist.

January 28, 1724.—The faking of expensive materials is not peculiar to the present day. On Jan. 28, 1724, a patent was granted to Robert Redrich and Thomas Jones "as well for staining, veining, spotting, clouding, damasking, and otherwise imitating the various kinds of marble, porphiry, and other rich stones and tortoiseshell, on wood, stone, and earthenware and all and every such goods, wares, utensils, and things, as are cut, made, or fashioned thereout."

January 28, 1832.—Steel pen nibs were known early in the last century, but they were not extensively used until James Perry, who had been making them from 1819 onwards, introduced the use of cross slits and apertures between the shoulder and the point. This construction he patented on Jan. 28, 1832. The firm of Perry and Co. was founded in 1829.

January 30, 1808.—The first band-saw was patented in England by William Newberry on Jan. 30, 1808, but it was thirty years and more before it came into practical use, and it was in France where it was fully developed. The two French patents of Mdlle. Crespin (1846) and M. Perin (1853) may be regarded as the foundation of the modern band-saw.

February 1, 1800.—One of the earliest patents for a screw propeller for ships was that granted to Edward Shorter on Feb. 1, 1800, for what he called a 'perpetual sculling-machine,' probably intended to enable large vessels to be manœuvred in a calm. Two or more blades similar to the sails of a windmill were mounted on a spar proceeding from any convenient part of the stern of the vessel obliquely downwards until its end dipped into the water, a buoy being provided to prevent it dipping too far. The spar was connected by a Hooke universal joint to a horizontal shaft, to which motion could be given by the capstan worked by man power or by a steam engine. By moving the spar transversely the ship could be steered. The invention is said to have been successfully tried on H.M. Ships *Dragon* and *Superb*.

February 3, 1818.—The patent for Jeremiah Chubb's original 'detector' lever lock is dated Feb. 3, 1818. The special feature of this lock was the use of a 'detector' device which came into action immediately if a wrong key with too long a bit were used in an attempt to open the lock, and effectively blocked the bolt until re-set by its proper key.

Societies and Academies.

LONDON.

Royal Society, Jan. 17.—**A. S. Eddington**: The charge of an electron (see p. 138 of this issue).—**R. H. Fowler**: The thermionic emission constant *A*. Nordheim's theory of the emission coefficient of electrons from metals is used to explain the remarkable relation between the constants *A* and χ of the thermionic emission formula, first recorded by O. W. Richardson and recently reformulated by Du Bridge. This theory regards the emission as due to the passage of electrons through simple surface potential steps and double layers, to be calculated according to the wave mechanics.—**J. A. Gaunt**: The triplets of helium.—**G. Temple**: The tensorial form of Dirac's wave equations. Darwin's transformation of Dirac's wave functions is incompatible with the theory of relativity. Dirac's wave equations are cast into tensorial form, from which are deduced the Lagrangian function, the charge and current tensor, the magnetisation and polarisation tensor, some associated quadratic invariants.—**H. M. Macdonald**: The reflection and transmission of electric waves at the interface between two transparent media.—**D. K. Bhattacharyya**: On the analysis of the first spark spectrum of sulphur. The data of Eder and Valenta between λ3028 to λ5819, and certain observations of Keeler and Lockyer regarding the occurrence of S^+-lines in stellar spectra, are used. The spectrum in the red region up to λ7715 was also photographed, using neocyanine plates and a Wood type of discharge tube. A band-system in the red, seemingly analogous to atmospheric bands of oxygen, has been found.—**J. S. Foster**: Effect of combined electric and magnetic fields on the helium spectrum. Parallel electric and magnetic fields are applied to a helium source, and the light analysed by a prism spectrograph of high dispersion. The effects in the parhelium and orthohelium spectra are clearly additive in the sharp and principal series, and for the components of the diffuse lines which are resolved. The magnetic separation is independent of the magnitude of the Stark-effect.—**R. W. B. Pearse**: The ultraviolet spectrum of magnesium hydride (1). In addition to the well-known visible (α) band system, two others, a β-system, represented by a strong band at λ2430 and a γ-system covering the range λ5500-λ2300, have been found in the ultra-violet.—**J. S. Foster and W. Rowles**: Patterns and Paschen-Back analogue in the Stark-effect for neon. In an attempt to determine Stark-patterns in neon, 150 lines were examined by the Lo Surdo method in fields as high as 140 kv./cm. An appreciable number of the diffuse and combination lines have a new pattern.—**J. K. L. MacDonald**: Stark-effect in a violet region of the secondary spectrum of helium. Effects for twenty lines are observed in the region 3980-4080 A. The Lo Surdo type of discharge tube is used; displacements are measured at a field strength of 95,000 volts per cm. Certain apparently complex effects are resolved into simple displacements of closely lying lines.—**J. S. Foster and M. L. Chalk**: Relative intensities of Stark components in hydrogen. A report of a quantitative investigation of the relative intensities of the stronger Stark components in the first four members of the Balmer series. In all cases the results agree within experimental error with the new calculations by Schrödinger.—**O. R. Baldwin**: The relativity theory of divergent waves. The solution given be Einstein for the general problem of the propagation of gravitational waves was used by Eddington to find the solution for waves created by a spinning rod. An attempt is now made to discover all the non-spurious waves of the same general character at infinity as Eddington's.—**G. W. C. Kaye and W. F. Higgins**: The thermal conductivity of solid and liquid sulphur. The temperature range was 20° C.-210° C. A 'plate' method with a small temperature drop across the specimen was used.—**S. Barrett and C. P. Stein**: On bromine chloride. From spectrophotometric observations on the colour changes on mixing carbon tetrachloride solutions of bromine and chlorine, the two halogens give an equilibrium concentration of bromine monochloride. The formation of a chemical compound between them is further indicated by the appearance of a new ultraviolet absorption band with its maximum at 3700 A., peculiar to the mixtures, and also by the fact that the colour change in carbon tetrachloride solution takes an appreciable time.—**C. W. Gibby, C. C. Tanner, and I. Masson**: The pressure of gaseous mixtures (2). The compressibilities, up to 125 atm., of helium, hydrogen, and ten mixtures of the two, at 25°, and of each pure gas and an equimolecular mixture at seven temperatures from 25° to 175° have been measured.—**J. Chariton and C. A. Lea**: Some experiments concerning the counting of scintillations produced by alpha-particles (Parts 1-3). (1) Determination of the smallest amount of luminous energy perceptible by the eye. (2) Determination of the efficiency of the transformation of the kinetic energy of the α-particle into radiant and luminous energy for various zinc sulphides. (3) Investigation of the way in which the number of scintillations observed is affected by the numerical aperture of the optical system used.

Geological Society, Dec. 19.—**W. J. Pugh**: The geology of the district between Llanymawddwy and Llanuwchllyn (Merioneth). The rocks belong to the Bala and the Valentian Series. There are important lateral changes within the Bala Series, and these reveal the transition from the succession described at Corris and Dinas Mawddwy to that around Bala. The Bala rocks become more arenaceous and more calcareous from south to north, and this general change in lithology is accompanied by a gradual increase in the number and variety of shelly fossils. Individual rocks are traced from the south to the Bala district, and direct correlation is made between rock groups represented by very distinct facies in the different districts. The district is situated on the eastern flank of the Harlech Dome, and the rocks strike from south-south-west to north-north-east. They dip east-south-eastwards, but there is some minor folding. There are important strike-faults, which conceal parts of the succession in certain localities. The rocks are highly cleaved. The strike of the cleavage-planes is approximately parallel to the strike of the strata, but the direction of cleavage-dip is variable.

PARIS.

Academy of Sciences, Dec. 26.—**Paul Appell**: On certain invariants.—**Charles Moureu, Charles Dufraisse, and Pierre Laplagne**: Autoxidation and antioxygen action. The catalytic properties of silicon, boron, and their derivatives. Details of results obtained with ten silicon compounds and six boron derivatives, with some typical curves.—**J. B. Charcot**: An arrangement allowing acoustic depth sounding in the polar regions. Description of a modified Marti recorder and of results obtained by its use.—**O. Borůvka**: A class of minimum surfaces in a five-dimensional space with constant curvature.—**Z. Horák**: The curvature of non-holonome varieties.—**L. Pirot**: Some determinations of the deviation from the vertical by means of the prism astrolabe. Results of observations made at Fort-de-France (Martinique), Pernambuco (Brazil), Lorient, Quiberon, and Brest.—**J. Errera**: Molecular associa-

tions. The relations between the viscosity of binary liquid mixtures and the polarity of the molecules of the constituents. The following conclusions are drawn from available data: when one of the components is dipolar and the other non-polar, the viscosity curve, if not a straight line, is always concave. When this curve is convex, the two components are always dipolar.—**A. Turpain and de Bony de Lavergne**: The magnetic field and Brownian movement.—**Maurice Curie and Adolphe Lepape**: The dielectric cohesion of the rare gases. Bouty's experiments with helium, neon, and argon were repeated with purer material, and krypton and xenon were also examined. In the series neon, argon, krypton, and xenon, the dielectric cohesion increases with the atomic number.—**L. Goldstein**: Some difficulties in the spontaneous emission of radiation.—**J. Cayrel**: The effect of a magnetic field on the electrical resistance of a contact.—**G. A. Beauvais**: Very short waves. The short waves described had a wave-length of 16-20 cm. They were reflected by parabolic and plane mirrors according to the laws of optics.—**Henri Belliot**: The development of inverted or solarised photographic plates after fixing.—**E. Carrière and P. Castel**: The experimental study of the transformation of chromates into bichromates.—**J. Orcel and S. Pavlovitch**: The microscopic characters of the oxides of manganese and of the natural manganites.—**P. Sédallian, A. Leulier, and Mme. Clavel**: The distribution and stability of the antigen properties of the diphtheric toxin. The rôle of the non-specific colloids.

Official Publications Received.

BRITISH.

Department of Scientific and Industrial Research. Report of the Building Research Board, with the Report of the Director of Building Research, for the Year 1927. Pp viii+132+10 plates. (London: H.M. Stationery Office) 3s. net.

Indian Central Cotton Committee: Technological Laboratory Bulletin No. 17: A Note on the Early History of Cotton. By A. N. Gulati and Arthur James Turner. (Technological Series, No. 12.) Pp 10. (Bombay.) 8 annas.

The Scottish Forestry Journal: being the Transactions of the Royal Scottish Arboricultural Society Vol. 42, Part 2, October. Pp. 35-110+28-38 (Edinburgh.) 7s 6d

Ollsgoil Na h-Eireann (The National University of Ireland). Calendar for the Year 1928. Pp viii+327+465. (Dublin)

Ministry of Health. Circular 939: Circular as to the Contents and Arrangement of the Annual Reports of Medical Officers of Health for 1928. Pp. 11. (London: Ministry of Health)

The Journal of the Institution of Electrical Engineers. Edited by P F. Rowell Vol. 67, No 384, December Pp. 124+xxxviii. (London E. and F. N. Spon, Ltd.) 10s. 6d.

Transactions of the Royal Society of Edinburgh Vol. 56, Part 1, No 5 On some points in the Anatomy and Habits of the Lophogastrid Crustacea By Dr S. M Manton Pp. 102-119+3 plates. (Edinburgh. Robert Grant and Son, London: Williams and Norgate, Ltd.) 3s

Air Ministry: Meteorological Office, London. Southport Auxiliary Observatory (The Fernley Observatory of the Corporation of Southport) Annual Report, and Results of Meteorological Observations, for the Year 1927. By Joseph Baxendell Pp 28. (Southport: The Fernley Observatory, London: Meteorological Office)

Scottish Marine Biological Association Annual Report 1927-28. Pp. 23 (Glasgow)

Nyasaland Protectorate. Report on some Diseases of Tea and Tobacco in Nyasaland By Dr. E J Butler. Pp 30+4 plates. (Zomba Department of Agriculture, London: Colonial Office)

Memoirs of the Indian Meteorological Department Vol 25, Part 2: Summary of Indian Rainfall for the Fifty Years 1875-1924 Pp. iii+15-108 (Calcutta: Government of India Central Publication Branch) 8 rupees; 13s 6d.

The Deeside Field. Issued under the Auspices of the Deeside Field Club. Fourth Number. Edited by J. B. Philip. Pp. vi+88+28 plates. (Aberdeen.) 3s. 6d.

FOREIGN.

Bulletin of the Terrestrial Electric Observatory of Fernando Sanford, Palo Alto, California Vol 5: Observations on Solar and Lunar Diurnal Variations of Earth Potential due to Changes in Distribution of the Earth's Surface Charge, including Two new Methods of recording such Variations, and on the accompanying Variations in the Atmospheric Potential Gradient for the Year 1927. Pp. 26. (Palo Alto, Calif.)

Contributions from the Dudley Herbarium of Stanford University. Vol 1, No 2: Preliminary Report on the Flora of the Tres Marías Islands. By Roxana Stinchfield Ferris. Pp. 32+4 plates. (Stanford University, Calif.: Stanford University Press.) 1.00 dollar.

Proceedings of the United States National Museum Vol 73, Art 12: A Revision of the Lizards of the Genus Ctenosaura. By Prof. John Wendell Bailey. (No 2733.) Pp. 58+30 plates. (Washington D.C: Government Printing Office)

Department of Commerce. U.S Coast and Geodetic Survey. Special Publication No 146: Radio Acoustic Position Finding. Pp. iv+62 (Washington, D.C.: Government Printing Office.) 20 cents

Department of Commerce: Bureau of Mines Coal in 1926. By F. G Tryon, O E. Kiessling and L. Mann (Mineral Resources of the United States, Part 2) Pp x+419-585 (Washington, D.C. Government Printing Office) 30 cents

Conseil Permanent International pour l Exploration de la Mer. Rapports et Proces-verbaux des Reunions Vol. 50 Whales and Whale Foetuses; Statistics of Catch and Measurements collected from the Norwegian Whalers' Association, 1922-25. By Sigurd Risting. Pp. iii+122 (Copenhague: Andr. Fred Høst et fils.)

Department of Commerce: Bureau of Standards Miscellaneous Publications, No. 88: Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce for the Fiscal Year ended June 30, 1928. Pp iv+46. (Washington, D C., Government Printing Office) 5 cents.

Proceedings of the United States National Museum Vol. 74, Art 3: New Fossil Pearly Fresh-water Mussels from Deposits on the Upper Amazon of Peru By William B Marshall. (No 2748) Pp. 7+1 plate. (Washington, D.C: Government Printing Office)

Section de Geodésie de l'Union Géodesique et Geophysique internationale. Publication spéciale No 2: Tables de l'ellipsoide de reference internationale adopte par l'Assemblée générale de Madrid le 7 octobre 1924 dans le système de la Division sexagesimale de la Circonference. Calculees sous la direction de Général G. Perrier par E. Hasse. Pp. 20+91. (Paris.)

U.S. Department of Agriculture. Farmers' Bulletin No. 1566: The Sorghum Midge, with Suggestions for Control. By C. H. Gable, W. A. Baker and L. C. Woodruff. Pp. ii+10 (Washington, D C.: Government Printing Office.) 5 cents.

Instituts scientifiques de Buitenzorg: "'s Lands Plantentuin.' Treubia: recueil de travaux zoologiques, hydrobiologiques et oceanographiques. Vol. 7, Suppl, Livraison 2, Novembre: Fauna Buruana; Acari. Von Dr. A. C Oudemans. Pp. 37-100. (Buitenzorg: Archipel Drukkerij.) 2.50 f.

Obras completas y correspondencia cientifica de Florentino Ameghino. Volumen 7: Los mamíferos fosiles de la República Argentina. Parte 2: Ungulados Edición oficial ordenada por El Gobierno de la Provincia de Buenos Aires. Dirigida por Alfredo J. Torcelli. Pp 524. (La Plata: Taller de Impresiones Oficiales)

R. Osservatorio Astrofisico di Catania. Catalogo Astrofotografico Internazionale 1900 0 Zona di Catania fra le declinazioni +46° e +55° Vol 7. Parte 2a: Declinaz. da + 52° a + 54°, ascens. retta da 3h a 6h. (Fascicolo N, 50) Pp. viii+36. Vol 8, Parte 2a: Declinaz da + 53° a + 55°, ascens. retta da 3h a 6h. (Fascicolo N. 58.) Pp viii+39. (Catania.)

Diary of Societies.

FRIDAY, JANUARY 25

BRITISH MYCOLOGICAL SOCIETY (London Meeting) (at University College), at 11 A M—Miss D. M Cayley Some Observations on Mycetozoa of the Genus *Didymium*—A. Chaston Chapman. A New Species of *Oidium*—Miss E. H. M. Farries: An Investigation on the Metabolism of *Nematospora Gossypii* Ashby and Nowell.—M. Mitra: *Phytophthora parasitica* Dast as a Parasite on Cotton Seedlings and Guava Fruit—Dr. A. Smith Observations on *Puccinia Menthae* Pers.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre—Dublin) (at Gaiety Theatre, Dublin), at 4.—Ll. B. Atkinson: How Electricity does Things (Faraday Lecture).

ASSOCIATION OF ECONOMIC BIOLOGISTS (Annual General Meeting) (in Botany Lecture Room, Imperial College of Science and Technology), at 5—S G. Tallents: The Work of the Empire Marketing Board

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Prof. C. V. Boys: A Fused Quartz Pendulum Rod for Clocks—G W. Sutton: A Method for the Determination of the Equivalent Resistance of Air-Condensers at High Frequencies—L. Hartshorn. The Measurement of the Anode Circuit Impedances and Mutual Conductances of Thermionic Valves.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section), at 5—Dr. F J. Poynton and Dr A. Moncrieff. A Case of Mediastinal Teratoma in an Infant

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Anatomy and Evolution of the Human Brain.

INSTITUTE OF TRANSPORT (Manchester, Liverpool, and District Section) (at Liverpool), at 6.30.—C. C. Taylor: The Reasons of Development of Road Transport in Recent Years.

ENGINEERING AND SCIENTIFIC CLUB (Wolverhampton), at 7.—A C. Baker, C O. Silvers, and others: Debate on Trams *versus* Buses

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Engineers' Club, Birmingham), at 7—Prof. W. E S. Turner: Some Important Minor Constituents in Glass.

INSTITUTION OF LOCOMOTIVE ENGINEERS (North-Eastern Centre) (at Hotel Metropole Leeds), at 7.—J C. Armstrong: Pulverised Fuel Locomotive.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section), at 7.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7—J. E Lea: Measurement of Coal Supplies in Small or Large Quantities.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. T. Usher: Bromoil.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE (at Royal Technical College, Glasgow), at 7.—J. Mitchell: The Manufacture of Iron and Steel Tubes

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Students' Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.15—S. Gibson The City of Winnipeg Hydro-electric Power Station.

BLACKBURN TEXTILE SOCIETY (at Bradford Technical College), at 7.30.—W. Wilkinson: Power Loom Pickers and Picking (Lecture)

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—M. J. McCarthy: Notes on Winches, Derricks, and other Lifting Appliances used in Modern Building Construction.
ROYAL SOCIETY OF MEDICINE (Epidemiology Section), at 8.—Dr. Ledingham, Dr. G. F. Buchan, and others: Discussion on Vaccination Against Smallpox in the Light of Recent Experience.
INSTITUTION OF PRODUCTION ENGINEERS (at 83 Pall Mall), at 8.—L. H. Pomeroy: The Designer *versus* the Production Engineer.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. A. C. Seward: The Vegetation of Greenland.

SATURDAY, JANUARY 26.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Southern District) (at Town Hall, Oxford), at 11.15 A.M.—H. V. Overfield and others: Discussion on Road Surfaces and a Standard of Maintenance.—W. L. Williams: Notes on the Construction of a New Public Convenience.
INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Gateshead-on-Tyne), at 2.45.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. E. Cammaerts: Flemish and Belgian Art (II.). The Landscape.

MONDAY, JANUARY 28.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in Cavendish Laboratory), at 4.30.—Sir Ernest Rutherford and Dr. J. Chadwick: Energy Relations in Artificial Disintegration.—R. H. Fowler: An Analogy for Beams of Particles of a Reciprocal Optical Theorem due to Helmholtz.—Dr. D. R. Hartree: The Distribution of Charge and Current in an Atom with Several Electrons Obeying Dirac's Equations.—N. Feather and R. R. Nimmo: The Distribution of Range of the α-particles from Radium C′ and Thorium C′.—*To be communicated by title only*:—R. M. Gabriel: Some Further Results concerning the Integrals of Moduli of Regular Functions along Curves of Certain Types.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Evans: Developmental Enterogenous Cysts and Diverticula.
INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—F. C. Raphael and others: Discussion on Mains Testing.
INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.—J. L. Carr: Recent Developments in Electricity Meters, with particular reference to those for special purposes.
ROYAL SOCIETY OF ARTS, at 8.—Dr. C. H. Lander: The Treatment of Coal (Cantor Lectures) (II.).
MEDICAL SOCIETY OF LONDON, at 8.—Dr. E. Spriggs and others: Discussion on Starvation in Treatment.
ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—G. B. Pritchard: The Origin and Prevention of Gingivitis.—A. T. Pitts: Two Compound Composite Odontomata.—Dr. J. Kingston Barton: The Prevention of Diseases of the Teeth in Children.—W. Rushton: The Use of Cement Linings in Cavities.
UNIVERSITY OF BIRMINGHAM CHEMICAL SOCIETY.—Dr. Twiss: Sulphur and Rubber.
INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Bristol).—Ll. B. Atkinson: How Electricity does Things (Faraday Lecture).
TODMORDEN TEXTILE SOCIETY (at Todmorden).—B. Sutcliffe: Steam Engine Testing (Lecture).

TUESDAY, JANUARY 29.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: Evolution and the Problem of Species (I.).
INSTITUTE OF ENGINEERING INSPECTION (at Royal Society of Arts), at 5.30.—B. P. Dudding: Errors in Testing Bulk Supply by Random Selection.
ELECTRICAL ASSOCIATION FOR WOMEN (at 15 Savoy Street), at 7.—F. W. Purse: How Electricity is Generated at West Ham (Lecture).
INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (Informal Meeting) (at North British Station Hotel, Edinburgh), at 7.—E. Seddon: Recent Extensions to Portobello Power Station.
INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—J. Wright and C. W. Marshall: The Construction of the Grid Transmission System in Great Britain.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—F. F. Renwick, Dr. T. Slater Price, and others: Discussion on Fixation.
INSTITUTE OF CHEMISTRY (Bristol and S.W. Counties Section) (at Bristol University), at 7.30.—E. Russell: Some Toxicological Cases.
SHEFFIELD METALLURGICAL ASSOCIATION (at Sheffield), at 7.30.—Prof. F. C. Lea: The Influence of Surface Conditions and Internal Stresses on the Physical Properties of Cold-worked and Quenched and Tempered Steels, with Particular Reference to Fatigue Resistance.
ROYAL ANTHROPOLOGICAL INSTITUTE (Anniversary Meeting), at 8.30.—Prof. J. L. Myres: Presidential Address.
MANCHESTER ATHENÆUM TEXTILE SOCIETY (at Athenæum, Manchester).—Dr. Urquhart: Cotton and Moisture (Lecture).

WEDNESDAY, JANUARY 30.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. G. E. Gask: The Treatment of Malignant Disease by Radium, with Demonstration of Patients who have been Treated.
INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.30.—H. G. Cousins: Design and Construction of Victoria House.
LIVERPOOL ENGINEERING SOCIETY (at The Temple, Liverpool), at 6.30.—J. Austin: Water Tube Boilers *versus* Scotch Boilers.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.—B. Reed: Locomotive Power and Proportions.
HALIFAX TEXTILE SOCIETY (at White Swan Hotel, Halifax), at 7.30.—C. T. Hobson: Short-time, its Effects and how to cost it (Lecture).
ROYAL SOCIETY OF ARTS, at 8.—G. Fletcher: The Shannon Scheme and its Economic Consequences.
GLASGOW ROYAL PHILOSOPHICAL SOCIETY (207 Bath Street, Glasgow), at 8.—Prof. W. Kerr: Vibration.

THURSDAY, JANUARY 31.

ROYAL SOCIETY, at 4.30.—Prof. S. Chapman: On the Theory of the Solar Diurnal Variation of the Earth's Magnetism.—Dr. G. M. B. Dobson, D. N. Harrison, and J. Lawrence: Measurements of the Amount of Ozone in the Earth's Atmosphere and its Relation to other Geophysical Conditions.—Prof. S. Chapman and J. M. Stagg: On the Variability of the Quiet-Day Diurnal Magnetic Variation at Eskdalemuir and Greenwich.—L. H. Gray: The Absorption of Penetrating Radiation.—*To be read in title only*:—R. d'E. Atkinson: The Probability of Excitation by Electron-Impact.—N. W. McLachlan: Pressure Distribution in a Fluid due to the Axial Vibration of a Rigid Disk.—J. D. Cockcroft: Skin Effect in Rectangular Conductors at High Frequencies.—L. Rosenhead: Systems of Line Vortices in a Channel of Finite Breadth.—Prof. T. P. Hilditch and N. L. Vidyarthi: (*a*) The Products of Partial Hydrogenation of some Higher Polyethylenic Esters; (*b*) The Products of Partial Hydrogenation of some Higher Monoethylenic Esters.—P. K. Kichlu and D. P. Acharya: Infra-red Radiations of Active Nitrogen.—Prof. T. H. Havelock: The Vertical Force on a Cylinder in a Uniform Stream.—R. C. J. Howland: Stress Systems in an Infinite Strip.—A. H. Wilson: Perturbation Theory in Quantum Mechanics.
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: The Early History of X-Rays (I.).
BIOCHEMICAL SOCIETY, BIRMINGHAM UNIVERSITY, at 5.30.—Chemo and Radio Therapy (Student Papers).
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—W. S. Farren: Monoplane or Biplane?
IMPERIAL COLLEGE CHEMICAL SOCIETY (in Main Chemistry Lecture Theatre, Royal College of Science), at 7.—Dr. T. Slater Price: Some Problems of Photographic Research.
INSTITUTION OF MECHANICAL ENGINEERS (Manchester Branch).—H. L. Guy: Modern Development in Steam-Turbine Practice.

FRIDAY, FEBRUARY 1.

ANDERSONIAN CHEMICAL SOCIETY (at Royal Technical College, Glasgow), at 3.15.—Dr. R. Hay: Manufacture of Sulphuric Acid by the Contact Process.
ROYAL SANITARY INSTITUTE, at 5.—F. R. Humphreys and others: The Civilian Population and Chemical Warfare.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. C. A. Pannett: Local Anæsthesia in the Surgery of the Upper Abdomen.
PHILOLOGICAL SOCIETY (at University College), at 5.30.—Prof. V. G. Childe: Philology and Archæology.
INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Prof. A. S. Eddington: Engineering Principles in the Machinery of the Stars (Thomas Hawksley Lecture).
SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (jointly with Liverpool Section) (at Engineers' Club, Manchester), at 7.—Dr. F. Challenger: The Sulphur Compounds of Shale Oil and Petroleum.
INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section), at 7.—J. L. Carr: Recent Developments in Electricity Meters, with particular reference to those for special purposes.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group—Informal Meeting), at 7.—P. Fripp: Some Aspects of Craftsmanship.
JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—T. H. Cross: Notes on Road Construction.
TEXTILE INSTITUTE (Lancashire Section) (jointly with Nelson Textile Society) (at Nelson), at 7.30.—O. S. Hall: The Economic Aspect of some Developments in the Textile Industry (Lecture).
ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Dr. R. D. Lawrence: Post-operative Acidosis.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. J. L. Myres: Geometrical Art in S.E. Europe and Western Asia.

SATURDAY, FEBRUARY 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. E. Cammaerts: Flemish and Belgian Art (III.): Genre Painting.

PUBLIC LECTURES.

SATURDAY, JANUARY 26.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. Harcourt: The Lure of India.

MONDAY, JANUARY 28.

KING'S COLLEGE OF HOUSEHOLD AND SOCIAL SCIENCE, at 5.15.—Sir Robert Witt: Dutch Art.
UNIVERSITY OF LEEDS, at 5.15.—Prof. A. Holmes: Radioactivity and Geological Time.
EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—Dr. H. E. Woodman: The Conservation of Young Grass for Winter Feeding as a Protein Concentrate.
SIR JOHN CASS TECHNICAL INSTITUTE, at 7.—F. S. Sinnatt: Coal Carbonisation: Theory and Practice (Introductory Lecture).
UNIVERSITY OF LEEDS, at 8.—Prof. J. R. R. Tolkien: Celts and Teutons in Early Times.

TUESDAY, JANUARY 29.

UNIVERSITY COLLEGE, at 5.30.—Prof. Karl Pearson: A New Theory of Progressive Evolution.

THURSDAY, JANUARY 31.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—H. V. Lanchester: Indian Architecture.
EAST LONDON COLLEGE, at 5.30.—Prof. R. Robinson: Some Aspects of Polarity Theories in Organic Chemistry.

FRIDAY, FEBRUARY 1.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—C. E. R. Sherrington: The Steam Railways and the Localisation of Industry in the Nineteenth Century.

SATURDAY, FEBRUARY 2.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: The Ancient Egyptian Potter and his Clay.

SATURDAY, FEBRUARY 2, 1929.

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Editorial and Publishing Offices :
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Fundamental Research in Chemical Technology.

INDUSTRIAL research has of late been much before the public eye, and in consequence an appreciation of its utility, if not of its methods or its meaning, has become general, even commonplace. Moreover, the public has learned to look to the universities for the nurture of that kind of investigation which may equally be termed profitable invention or pure research, according to the point of view of the observer. Intensive and accurately directed attacks on specific industrial problems, organised by technical men, have scored many notable successes and made important contributions to general scientific knowledge. With a single industrial aim in view, however, the tendency has frequently been to ignore side-tracks, whether or not they might lead to a broad highway of advance, and to reach the goal in ways that commend themselves to business men as economically desirable. One would say nothing whatever to disparage or discourage this type of research. Resting on fundamental bases usually already in existence—frequently on pillars which have been slowly and laboriously built up in the intellectually invigorating but financially rarefied atmosphere of a university—it has gone far towards consolidating the industrial position of Great Britain in the changed conditions of a post-War world.

It is therefore well to have in mind the character and the quality of the work which is going on among the foundations of the industrial edifice. During the past sixteen years there has, for example, been gradually growing up at the Imperial College of Science and Technology, South Kensington, a school of fuel technology and combustion research, chemical engineering and electrochemistry (together forming the Department of Chemical Technology), of which the British Commonwealth may well be proud. Directed by Prof. W. A. Bone, with the assistance of Prof. J. W. Hinchley (professor of chemical engineering) and Capt. G. I. Finch (assistant professor of electrochemistry), and hitherto supported without any public appeal by the resources of the College supplemented by generous donations from external sources—an achievement of no mean order, since the financial provision required for buildings and equipment alone has already amounted to some sixty thousand pounds—it has now reached a condition in which, after patient preparation, it is on the point of launching a concerted attack on the complex problems presented by reactions between

gases under extremely high pressures. Little indeed is known concerning the domain to be explored, but its study elsewhere in one particular direction, namely, the catalytic interaction of hydrogen and nitrogen, has already resulted in the establishment in Great Britain of a great new chemical industry, comparable with that which originated from similar researches in Germany; further, Prof. Bone's own work with pre-explosion pressures up to 200 atmospheres or so has completely dispelled any reasonable doubt as to whether the excursion justifies the labour and cost which it must involve.

An example of the unexpected behaviour of gas mixtures when exploded at these pressures, in future to be regarded as moderate only, is significant. It will be appreciated that, apart from chemical factors and the influences of temperature and pressure, other considerations such as radiation effects have to be taken into account in interpreting the experimental results obtained in the study of gas reactions under pressures higher than those normally employed. Hence, by the activation of molecules, unexpected new reactions may play a considerable part in the changes which may be followed under such conditions. In point of fact, Prof. Bone and his collaborators have already found that whilst the replacement of even small amounts of carbon monoxide in admixture with air by hydrogen has a very marked influence in accelerating the rise of pressure on explosion, nitrogen retards the attainment of maximum pressure to a surprising degree; moreover, less pressure is developed, and the subsequent cooling is retarded. Evidently, much of the radiation emitted by combustion of the carbon monoxide had been absorbed by the nitrogen (which thereby became activated) and afterwards liberated as heat.

The question of the effect of the presence of moisture on the combustion of carbon monoxide is also one to which a considerable amount of attention has been devoted. Spectroscopic studies of flames of mixtures of carbon monoxide with hydrogen, and experiments on the relative ease of ignition of partly dried mixtures of carbon monoxide with oxygen, have led to the view that undried carbon monoxide interacts simultaneously with oxygen and with water molecules; moreover, the effect of pressure in overcoming the difficulty of causing a dry mixture of carbon monoxide and oxygen to burn is such as to suggest that at high initial pressures the former is the sole course of the reaction. On the other hand, in an ordinary water-gas flame the combustion is almost exclusively indirect, and in either case the probability of some degree of activation or ionisation of the reacting gases cannot be excluded.

Although Prof. Bone is actively developing investigation into certain catalytic reactions, and has designed and had built apparatus with the view of following up results which he has already obtained, his principal aim at present is to extend his fundamental studies of gaseous combustion and explosion in such a manner as would, but a few years ago, have been regarded as beyond the range of practical engineering politics. The investigations, it must again be emphasised, are of an essentially fundamental character; whilst the results which will accrue can scarcely fail to be of major significance in modern practice, the programme will not be confined to immediate needs, or be conceived in narrow terms. The tender plant of a new technique, almost a new science, will be encouraged to develop, to blossom, and to bear fruit under conditions which provide the best possible opportunities for healthy existence and natural growth. Such conditions include the provision of highly trained specialists to lead the 'teams' of researchers, the design and construction of new and costly apparatus, and—for the work is not without risk—ample space and especially appropriate buildings. The nucleus of the staff, thanks to Prof. Bone and his colleagues, is ready; a substantial portion of the new apparatus required for the experiments in immediate prospect has recently been constructed at a cost of some £3300; and as much work is already in progress as can safely be conducted in the limited accommodation offered by the uncompleted buildings of that department of the Imperial College. That its activities, closely related as they are to the needs of the great industries of the mother-land, should not be confined within metropolitan or even insular boundaries, is only to be expected.

The support which responsible commercial organisations have accorded, and continue to grant, to this department of the Imperial College is perhaps itself proof of a realisation that independence of thought and of action, such as is characteristic of the university and is associated with freedom in the exchange of views and ideas, is not at variance with aspirations and considerations necessarily arising out of the hard facts of an industrial situation. It is, after all, a wisely invoked co-operation, rigid here and elastic there, between science and industry which best lubricates the wheels of progress without clogging their differential gear.

The Conductivity of the Atmosphere.

The Electrical Conductivity of the Atmosphere and its Causes. By Prof. Victor F. Hess. Translated from the German by L. W. Codd. Pp. xviii + 204. (London: Constable and Co., Ltd., 1928.) 12*s.* net.

PROF. VICTOR HESS'S book on the conductivity of the atmosphere was published in German in 1926, and was appreciated as the first adequate account of the subject. A hearty welcome to the English edition is assured. The work deals in orderly fashion with the measurement of conductivity, with the nature of the ionisation to which conductivity is due, with the causes which produce ionisation, and with the processes by which ions are destroyed. Of the causes which produce ionisation, the most important is the highly penetrating radiation discovered by Hess himself, and to many readers the section dealing with this radiation will prove the most interesting part of the book. The clear way in which the story is told and the restraint with which the author has abstained from spoiling the balance of the book will be admired, but we may regret that he has not gone into more detail, especially with regard to his own pioneer work.

The first step towards the discovery of the highly penetrating radiation was taken in 1901, when it was announced by Elster and Geitel, and almost simultaneously by C. T. R. Wilson, that enclosed air was continuously ionised. By 1903 it was known that the ionisation was largely due to radiation which could be cut off by heavy screens surrounding the enclosure. By 1908 it had been demonstrated that a large part of this penetrating radiation came from the ground, but observations made at such places as the top of the Eiffel Tower had indicated that the radiation did not decrease with increasing height so rapidly as had been anticipated. In 1910 the first observations in balloons were published. Hess not only improved the apparatus used for measuring the penetrating radiation in a balloon, but also made no less than ten ascents, the highest being to 5400 metres. He found in 1911 that there was a slight decrease of the total radiation up to 1000 metres, then a slow, and finally a rapid increase of the radiation. From this discovery he deduced the existence of a hitherto unknown radiation entering the atmosphere from above and of greater hardness than the known gamma rays. Hess's observations were immediately confirmed by Kolhörster, whose highest ascent reached 9 km. above ground.

In the last few years there has been great activity in the investigation of the ultra-gamma radiation in many parts of the world, notably in America. It is generally believed that this radiation comes from outer space with no preference for any special parts of the sky. Hess quotes the experiments of Kolhörster made on a glacier near the Jungfrau during three summers, from which it appeared that there was a diurnal variation with an amplitude of 15 per cent. The maximum seemed to coincide with the zenith position of the Milky Way and neighbouring regions of the sky. On the other hand, the latest observations,[1] those made by Steinke in the Engadine with improved apparatus, show no influence of stellar time. Steinke's apparatus was sensitive enough for the influence of varying barometric pressure on the absorption of the ultra-gamma radiation to be measured. Clearly, the extension of measurements of the same order of accuracy to other latitudes is desirable. It is to be noted that Hess still regards it as possible that the ultra-gamma radiation is produced in the outer atmosphere of the earth in response to some stimulus from the sun. He suggests that measurements of the penetrating radiation in the auroral zone would settle this question. Less cautious philosophers are convinced that the radiation comes from distant space. In his Trueman Wood lecture, Sir James Jeans says: "There is no reason to doubt that it originates just where it ought to, namely, in the great nebulæ. . . . In a sense this radiation is the most fundamental physical phenomenon of the whole universe." May we add that there is no reason to doubt that some day we shall have telescopes designed to give measurements of the ultra-gamma radiation from individual nebulæ, measurements which will lead to new knowledge of the structure of the universe.

Turning to the main subject of the book, we note that the conductivity of the air near the ground is such that the half-time period for the dissipation of the charge on an exposed conductor is roughly 15 minutes. The air at 9 kilometres conducts ten times as well. The small ions to which the conductivity is due have but short lives. Their usual fate is to be caught by their larger neighbours, the Aitken nuclei, within a minute after their creation.

It is found that on land the small ions are mostly generated by radioactivity. According to Hess's summary, the radium and thorium emanation in the air produce about 5 ions per c.c. per second,

[1] E Steinke, *Zs. f. Phys.*, 48, pp 647-689; 1928. Abstract by Hess, *Zs. f. Geophys.*, 4, pp. 121-123; 1928.

the α-rays being the most effective. The γ-radiation from the radioactive substances in the earth accounts for 3 ions per c.c. per second. To the 8 ions produced by radioactivity must be added $1\frac{1}{2}$ produced by ultra-gamma radiation, so that $9\frac{1}{2}$ ions per c.c. are produced each second altogether in the cubic centimetre. The most conspicuous variations in conductivity at one place are probably due to variations in the number of nuclei waiting to catch the small ions. In a fog, the small ions are caught so quickly that the conductivity assumes a very low value. On the other hand, variations between localities may be associated with the geological conditions which determine the radioactivity of the ground and of the emanation which is exuded from the ground. The high potential gradient and low conductivity of the air near London may be attributed to the slight radioactivity of London clay as well as to the pollution of the atmosphere. Hess points out that there is no part of the world for which the balance of ionisation is thoroughly known. One factor has been observed by an investigator here, another there. Observatories equipped to record all the elements simultaneously and continually are required.

Whilst the ionisation over the land is mostly caused by radioactivity, that over the oceans is to be attributed to the ultra-gamma radiation. It is perhaps a mere coincidence that the effective ionisation is about the same over land and sea; where there are several ionising agencies, there is also an excess in the number of nuclei ready to absorb the ions.

The important subject of the ionisation of the upper layers of the atmosphere is dealt with very briefly. The introductory paragraph on the composition of the air in these upper layers requires revision already. It is stated that the temperature of the atmosphere above 30 km. is unknown, and the calculations made by Humphreys of the density at heights up to 120 km. on the assumption of a uniform temperature of $-55°$ are quoted. The higher density required by the Lindemann-Dobson theory of meteors and by the records of 'abnormal audibility' is not mentioned. Recent discussions of the auroral spectrum lend no support to the doctrine that the atmosphere at 70-80 km. and upwards consists chiefly of hydrogen. The importance of these comments lies in the fact that Hess gives a table of the conductivity produced by penetrating radiation. The table depends on the assumed density of the air, and should therefore be used with great caution.

The sketch of the part played by the Heaviside layer in the transmission of wireless waves is brought up-to-date, but there is no account of the evidence from terrestrial magnetism for the existence of such a layer. This is the more remarkable, as it is mentioned that Balfour Stewart had "advanced a similar idea" in 1883, long before wireless telegraphy was thought of. It is to be hoped that in another edition some account of the brilliant work of Schuster and Chapman in elaboration of Balfour Stewart's idea will be given.

The book is a pleasure to read, not only on account of the clear exposition of the author, but also because of the smooth English of the translator. The stimulus to the study of atmospheric electricity will be felt in many quarters.

A work of this character has to be read backwards and forwards, and it is therefore particularly unfortunate that the publishers have seen fit to print across the top of every pair of pages the same heading—the electrical conductivity of the atmosphere. Such a heading does not help anyone who is looking for details of some special part of the subject. It is to be hoped that when the second edition is produced, the normal practice of varying the page headings from chapter to chapter will be followed. F. J. W. W.

Classification of the Higher Ferns.

The Ferns (Filicales); treated comparatively with a View to their Natural Classification. Vol. 3: *The Leptosporangiate Ferns.* By Prof. F. O. Bower. Pp. viii + 306 + 2 plates. (Cambridge: At the University Press, 1928.) 30*s.* net.

IN a book of some three hundred pages, beautifully produced and amply illustrated, Prof. Bower has now given us his considered views on the classification of the higher ferns. Both author and publishers are to be congratulated on this work, the former on his consistent treatment of a truly difficult subject which has long called for revision, and the latter on the dignity of the volume itself.

With admirable open-mindedness, Prof. Bower tells us, in effect, that while as the work has advanced, the older classification has suffered many changes in the light of the facts of development, the new classification now offered is by no means final, but must be used as the point of departure for further research, from which may later emerge other conclusions than those now adopted. Reluctantly one is forced to doubt the validity of old comprehensive genera of higher ferns, long accepted, as the evidence from development is laid open in the pages of this book, for the characters on which these

genera have stood provide, indeed, the only criteria readily available to the average worker in the field. This, however, is inevitable to progress, and we are given a new conception of affinity with loosened bonds, a wider view of the complexity of the problems of the ferns, and a readier understanding of the diverse origins of advanced organisms as a whole.

The classification now offered is based in part on characters of development, many of which are observable by the laboratory worker alone, and involving for their fuller appreciation an extensive knowledge of the intimate details of growth. This also is inevitable to progress and must lead in time to more intensive study of the characters themselves, and, perchance, to their widening or revaluation as knowledge of fern physiology is advanced. "To travel hopefully is better than to arrive," is the faith of the author, who aims at no finality in the new classification offered, but seeks to stimulate further inquiry on every possible line.

The general conception of the book is simple, in that it presents, chapter by chapter, a brief and clear statement of the varied views on affinity which have been held for the genera considered. A central genus is then chosen, examined in detail of habit, adult structure, and reproduction, and revised in the light of sporangial development, form, and spore-production. The same principles are involved as in the preceeding two volumes, with which the reader must be fully familiar if the author's findings are to be grasped ; for at many points the matter is condensed and argument on the significance of the characters considered is strictly avoided. For this reason the book calls for intensive reading and might well have benefited by extended argument, for the characters of many of the genera considered are so varied—some being viewed as primitive and others as advanced—that a clear picture of the position of a genus can be readily obtained only by one familiar with the intricacies of the subject. This is, however, of the nature of the case, as, for example, with the Pteroid ferns which have hairs or scales, solenostelic or dictyostelic conductive systems, open or reticulate venation, a double or single indusium, and may have the sporangial receptacle on the leaf margin or superficial with the sporangia spread in the Acrostichod manner.

It is only when the reader has fully studied in detail the genera which the author has grouped round his central types that the true value of his method is apparent. It is then seen that his aim is not to reduce the ferns to a ready scheme for identification, but to give the reader a fuller view of the plasticity of living things, which, though loosely akin, have each gone their own way in descent, and have attained a distinctive individuality which has not wholly masked their origin. It is soon apparent that the characters of general anatomy are no longer to be expected to march abreast in the phyletic advance, and that primitive features may persist or be lost at many points in the progression from the ancestral stock. The spore-bearing organs alone are then considered relatively conservative and trustworthy, and to them the author's faith is mainly pinned. Thus a sporangial mass of marginal origin may tend to pass to a superficial position in the development of the individual, and to a greater extent in the race, the order of sporangial development may be modified, the form of the sporangia themselves may be in a state of change, and the spore output may not yet have settled temporarily to a stable condition. The problem of the individual fern, and its present state rather than its final resting-place in a systematic scheme, indeed become the themes of the book, and the reader finally emerges from an intensive struggle with characters, which have only relative values, with a truer appreciation of the expressions of life than that with which he entered on his study.

Some eleven chapters are devoted to the Davalloid, Pteroid, Gymnogrammoid, Blechnoid, Dryopteroid, and Dipteroid ferns, and each is closed by a well-chosen bibliography. Of these the chapters on the Gymnogrammoids and Blechnoids are intensely interesting, and to those who have worked with the cold systematic treatment of the older classification they are a revelation in evolutionary study.

It is not to be expected that in a study such as this, which seeks to loosen affinities, all the organisms considered should find a ready place in a systematic scheme. Accordingly, a series of genera, including *Cystopteris*, *Acrophorus*, *Monachosorum*, *Prosaptia*, *Deparia*, and *Salvinia*, are treated apart in a chapter on uncertain affinities. The treatment here is necessarily brief, and prefigures some later pronouncement when the field of fact is widened.

The two final chapters are devoted to the summary of results and their bearing on evolutionary theory. Here the author shows clearly that he views his study as indicating the present drift of evolution among the higher ferns rather than defining clearly their evolutionary history, for which he offers a probable picture of earlier events rather than a definite demonstration, for the fossil record is too uncertain and fragmentary. One may do well to read these chapters in detail before the systematic study of the book is begun, as in them the viewpoint

of the author is beautifully expressed towards systematic study as a whole. It may truly be said that with the preceding volumes Prof. Bower has now given us a classical study on affinity, replete with suggestion for work on many lines, and marked by a power of expression which many will envy and admire.

J. McL. Thompson.

South African Desiccation and the Bushmen.

The Kalahari and its Native Races: being the Account of a Journey through Ngamiland and the Kalahari, with a Special Study of the Natives in that Area. By Prof. E. H. L. Schwarz. Pp. 244 + 24 plates. (London: H. F. and G. Witherby, 1928.) 16*s*. net.

Lake Ngami has played a conspicuous part in the discussion whether South Africa is undergoing a progressive desiccation which threatens its whole future, or whether the climatic changes that have happened are temporary fluctuations. The late Prof. Schwarz, during his ten years' work on the Geological Survey of Cape Colony, realised the extent to which some parts of the country have been impoverished by drought. He devoted himself to the question of how this alarming process could be checked, and in 1918 published his well-known scheme for the diversion of water from the Zambezi into the great depressions of Lake Ngami and the western Kalahari.

In 1925, while on the Kalahari Reconnaissance Expedition, sent by the Government to investigate his proposals, Prof. Schwarz found the country suffering from floods, and he returned by canoe from the Victoria Falls to Lake Ngami, which was reoccupied by water, and down the Botletle River until it disappeared in the desert; he then, by an arduous waggon journey, crossed the Kalahari to the railway at Palapye. The book describes this journey, which is of special interest, as the country was then restored to the condition familiar from its description by Livingstone. "A country," says Prof. Schwarz, "that had resigned itself to the condition of permanent drought was for a time gladdened by the sound of rippling water on all sides" (p. 13). A valuable table summarises the history of Lake Ngami from 1760, when it was dry; during the period when it was a great lake, from 1813 to Livingstone's visit in 1849, when it had then begun to decline; from 1854 until 1861, when it held some shallow water surrounded by reeds; and from 1896 until 1922, when there was no water, and the lake-bed was a dry plain. The restoration of Lake Ngami is regarded as evidence of a cyclic climatic change. The account is conclusive that Africa is not threatened by progressive natural desiccation.

The volume describes important features in the geology of the country. The Zambezi Valley above the Victoria Falls is regarded as a recently made rift valley, seven miles wide, with fault-walls 250 feet high, and to this valley is attributed the diversion of the Zambezi and formation of the Victoria Falls. The basin of Lake Ngami is described as also due to a subsidence bounded by faults of recent date.

Prof. Schwarz's work was always characterised by variety of interest and daring originality, and these features are shown in his interesting account of the Bushmen. Evidence is summarised to show that they ranged all through Africa, and into Asia, and it is claimed that some of the South African natives show Australian and Patagonian affinities. The Mongoloid features of some of them are attributed to settlements of Chinese in East Africa in the tenth and eleventh centuries. This view is supported by reference to the Ming pottery found in Kenya Colony, but it is adequately explained as brought by the Arabs, who had acquired it during the overland trade between China and the Persian Gulf. The migration of Malays to Madagascar is well established; but Prof. Schwarz claimed a Malay origin for the Makalaka who live at the normal end of the Botletle River, and of the Nyam-Nyam of the Upper Nile. In regard to the Hereros, the claim is quoted that their matrilineal descent is due to their ignorance that man has anything to do with parentage, and a more reasonable explanation of that custom is adopted.

The book is a valuable contribution to the recent condition of South Africa by an exceptionally keen observer, who was never afraid of unorthodox deductions.

Our Bookshelf.

Elements of Optical Mineralogy: an Introduction to Microscopic Petrography. By Prof. Alexander N. Winchell. Third edition, revised and enlarged. Part 1: *Principles and Methods*. Pp. viii + 238. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1928.) 17*s*. 6*d*. net.

Within the last few years there have been marked advances in petrographic-microscopical technique, and Prof. Winchell, in the revised edition of his well-known text-book, has incorporated selected examples in a chapter entitled "Special Methods of Study." Under this heading he deals with the application of Fedorow methods to the study of thin sections, and in addition, the modern dis-

persion methods of refractive index determinations with immersion oils. The former are now in almost universal use on the Continent, and have been found to be invaluable in the discrimination of plagioclase felspars. The various adjustments of the universal stage are explained, and the author gives full instructions for the location and plotting of symmetry planes and other symmetry elements, bringing out in a very clear manner the extreme simplicity of the method.

Dispersion methods are essentially an improvement on the ordinary immersion methods of refractive index determinations, the refinements not only increasing the accuracy but also decreasing the number of oils necessary. With the double dispersion methods, only thirteen oils are necessary to cover the whole range of refractive indices, ordinarily requiring about sixty oils. The theory depends on the fact that increase of temperature decreases the refractive index of a liquid, whereas that of a solid remains practically constant, and decrease of wave-length of light increases the refractive index of a liquid to a much greater degree than that of a solid. The single-dispersion method employs only the first, while the double-dispersion method employs both. The measurements for the case of quartz are given as an example of the latter, and, in addition, dispersion curves for thirteen liquids are supplied.

The American Indian Frontier. By Prof. W. C. Macleod. (The History of Civilisation Series.) Pp. xxiii + 598. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, 1928.) 25*s*. net.

IN the classification of the subject matter of "The History of Civilisation" Series, Prof. Macleod's book on the Indian frontier falls into the section entitled "Historical Ethnology," being the fourth to be so included. That such a section should prove of great utility there is no question, though this is perhaps not the occasion to discuss whether the three volumes previously included conform strictly to its requirements; but there can be no two opinions as to the suitability for inclusion of Prof. Macleod's book. He surveys frontier relations between European and Indian from the Indian side of that border line, stressing the institutional changes from precedent conditions which have been brought about by contact and ending with an analysis of conditions as they are to-day.

Prof. Macleod has had a highly complex question to consider, which has involved the examination of a vast mass of detailed evidence. The Colonial policies, for example, of the different European nations involved, whether in war or in peace, are alone an enormous labour to disentangle, while trade relations, if not so extended or complex, entail a most difficult and tedious research. Prof. Macleod's book is a valuable contribution to ethnological and historical literature, but it is more than that. It is a document which should serve as a guide and a warning in our relations with peoples of non-European culture to-day.

Bibliography of Sponges, 1551–1913. By the late Prof. G. C. J. Vosmaer. Edited by Dr. G. P. Bidder and C. S. Vosmaer-Roell. Pp. xii + 234. (Cambridge: At the University Press, 1928.) 15*s*. net.

WHEN G. C. J. Vosmaer died in 1916, he left, all but completed, a monograph on the sponges of the Bay of Naples, on which he had been at work for more than thirty years. Those familiar with the fine quality of his work anticipated great things from this monograph, and it is to be hoped that it may yet be found possible to publish it. Meanwhile the piety of his widow, Madame Vosmaer-Röell, and of his friend Dr. G. P. Bidder, has led them to edit and publish as a separate volume the exhaustive "Bibliography of Sponges, 1551–1913," which he had prepared for the monograph.

Lacking the final touches of the compiler, whom no editor, however painstaking, can perfectly replace, the bibliography, as Dr. Bidder points out, has some imperfections, but they are not of a kind or magnitude likely to impair seriously its usefulness. Like most Continental bibliographers, Vosmaer does not seem to have been aware of the rich store of bibliographical information contained in Mr. B. B. Woodward's "Catalogue of the Library of the Natural History Museum." No one, however, will in the future attempt the serious study of sponges without this volume at his elbow, unless he be one of those younger biologists to whom Dr. Bidder feelingly alludes, who "incline to cut themselves loose from the lengthening chain of literature, and to read nothing that has appeared more than twenty years ago." To these, a consideration of the concluding paragraphs of Dr. Bidder's preface may be strongly recommended.

A Textbook of Biochemistry: for Students of Medicine and Science. By Prof. A. T. Cameron. Pp. x + 462. (London: J. and A. Churchill, 1928.) 15*s*. net.

PROF. CAMERON'S book appears to be a useful addition to bio-chemical literature; it provides an up-to-date and broad outlook on a subject which is advancing so rapidly that a chapter may become out-of-date even before it is printed. The author feels that bio-chemistry has its applications in other sciences besides physiology, and to break down some of the water-tight compartments which so often exist between them, has included chapters on the chemistry of immunology, on the utilisation of bio-chemical processes in industry, and on the relationship of bio-chemistry and pharmacology; in addition, chapters are devoted to comparative digestion, and to chemical actions brought about by moulds and bacteria. In a future edition it might be advisable to amplify somewhat the sections on internal secretions and the vitamins, substances of immense importance to the animal economy.

Although more suitable perhaps for the student of bio-chemistry, the work could be read with profit by the medical student, and also by those who wish to be in touch with the latest developments of the subject. Each chapter has a few references appended, chiefly to monographs or reviews, in which those interested can obtain the fuller information they may desire.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Raman Effect with Liquid Oxygen, Nitrogen, and Hydrogen.

IN some experiments we recently made to see if a Raman effect could be observed with homopolar molecules, we found that the spectrum of the light scattered by liquid air included six sharp and clearly defined lines not included in the irradiating light, which was that from the mercury arc. The wave-lengths of these lines were approximately 4317·7 A., 4674·3 A., 5026·5 A., 4468·9 A., 4849·3 A., and 4980·3 A. They with their frequencies are given below.

Element.	Exciting Radiation.		Scattered (Raman) Radiation.			$\Delta\nu$ observed.	$\Delta\nu$ calculated from Band Spectra Data.
	λ (A).	ν (vac.).	λ.	Int.	ν (vac.).	cm.$^{-1}$	cm.$^{-1}$
Oxygen	4046·6	24,705	4317·7	1	23,154	1552	1554
	4358·3	22,938	4674·3	2	21,387	1551	1554
	4358·3	22,938	5026·5	0	19,889	3049	3085
Nitrogen	4046 6	24,705	4468·9	1	22,371	2335	2331
	4358·3	22,938	4849·3	00	20,616	2322	2331
	4046 6	24,705	4980·3	0	20,073	4632	4633

The experiment was repeated with pure liquid oxygen and again with pure liquid nitrogen, and it was found that the wave-lengths 4317·7 A., 4674·3 A., and 5026·5 A. only were obtained with liquid oxygen, and the wave-lengths 4468·9 A., 4849·3 A, and 4980·3 A. only with liquid nitrogen. The existence of two of the Raman lines with each liquid can be explained by supposing them to arise from irradiation by light of the two wave-lengths 4358 A. and 4047 A. The frequency difference for the mercury line 4047 A. and the Raman oxygen line 4317·7 A. is 1552 cm.$^{-1}$, and for the mercury line 4358 A., and the Raman oxygen line 4674·3 A. is 1551 cm.$^{-1}$. With the nitrogen lines, the one, 4468·9 A., has a frequency difference with the mercury line 4047 A. of 2335 cm.$^{-1}$, and the other, 4849·3 A. with the mercury line 4358 A., one of 2322 cm.$^{-1}$.

It would seem that a mean vibration frequency of approximately 1551·5 cm.$^{-1}$ was involved in the Raman effect with liquid oxygen and a mean vibration frequency of approximately 2328·5 in the Raman effect with liquid nitrogen.

From the *Bulletin of the National Research Council*, vol. 11, Part 3, No. 57, on "Molecular Spectra in Gases," p. 232, 1554 cm.$^{-1}$ is indicated as the primary vibration frequency of the oxygen molecule in its normal state, and 2331 cm.$^{-1}$ as that of the nitrogen molecule in its normal state. The two-quantum vibration state of oxygen would appear to be 3085 cm.$^{-1}$ and that of nitrogen 4633 cm.$^{-1}$.

Our results would suggest that the primary vibration frequencies are the ones involved in the production of four of the Raman lines observed by us. The other two lines, it would seem, are produced by absorptions corresponding to the frequencies of the second vibration states of the two elements, for if with oxygen the exciting mercury line is taken to be 4358 A., the frequency difference between it and the Raman line at 5026·5 A. is 3049 cm.$^{-1}$, and with nitrogen, if 4046·6 A. of mercury is taken as the exciting line, the frequency difference between it and the Raman line at 4980·3 A. is 4632 cm.$^{-1}$.

In experiments with liquid hydrogen irradiated with light from the mercury arc, we found that in addition to the usual mercury lines there were included in the spectrum of the scattered light lines corresponding to wave-lengths 4426·6 A., 4473·1 A., and 4863·5 A. These with their frequencies are given below.

Element.	Exciting Radiation.		Scattered (Raman) Radiation.			$\Delta\nu$ observed.	$\Delta\nu$ calculated from Band Spectra Data
	λ (A.).	ν (vac.).	λ (A.).	Int.	ν (vac.).	cm.$^{-1}$	cm.$^{-1}$
Hydrogen	4358·3	22,938	4426·6	2	22,584	354	347
	4358 3	22,938	4473 1	4	22,350	588	578
	4046 6	24,705	4863 5	1	20,556	4149	4159

By the use of suitable light screens, it was found that 4426·6 A. and 4473·1 A. were excited by the radiation 4358·3 A., and 4863·5 A. by radiation 4046·6 A. The available data on the band spectra of hydrogen enable one to show that 347 cm.$^{-1}$ and 578 cm.$^{-1}$ are the frequencies corresponding respectively to $0 \rightarrow 2$ and $1 \rightarrow 3$ rotational transitions for hydrogen molecules in the zero vibrational state. It can be shown, too, that 4159 cm.$^{-1}$ is the frequency of a $0 \rightarrow 1$ vibrational transition for hydrogen molecules in the zero vibrational state. From the numbers given in the table, it will be seen that the Raman effects we observed with hydrogen were due to these three transitions.

The results are interesting in that they constitute a series of violations of generally accepted selection rules. They show (1) that Raman effects can be obtained with homopolar molecules; (2) that part of the energy of light quanta can be taken up directly as rotational energy, the balances appearing as quanta degraded in frequency; and (3) that two-quantum rotational transitions can be demonstrated in connexion with light-scattering phenomena.

The results of the experiments, moreover, constitute experimental proof of the correctness of Dennison's view that hydrogen at low temperatures must be regarded as a mixture of two effectively distinct sets of molecules, symmetrical and antisymmetrical. According to our results, we have in liquid hydrogen (1) some molecules in the zero vibrational and zero rotational states, and (2) others in the zero vibrational and first rotational states. Our intensity measurements show that there were in the latter states considerably more (about twice as many) molecules than in the former ones. The 'distinctness' of the two states is emphasised by the fact that no Raman effects were obtained corresponding to $0 \rightarrow 1$ or $1 \rightarrow 2$ rotational transitions.

J. C. McLENNAN.
J. H. McLEOD.
University of Toronto, Dec. 20.

The Understanding of Relativity.

MAY I have space for a last letter about the difficulties of the ordinary man with respect to relativity and kindred puzzles? Of course there is such a thing as relativity. We take it into account in daily life. But I cannot believe that modern mathematicians have overthrown fundamental axioms of thought. Such dictionaries as I have consulted define parallel lines as those which keep equidistant from each other. But a spiral wound around a straight line might keep equidistant, and yet not be parallel. Presumably parallel lines are those which keep equidistant on the

same plane. If that be true, lines of longitude are not parallel for even an inch. But if lines were drawn from points at a given distance on opposite sides of one pole to points in similar relation to the other pole, they would be parallel—like lines of latitude drawn equidistant from the equator. To define parallel lines as those which meet at infinity is merely to confuse the learner by giving a contradictory meaning to an old word. It may be that lines which *seem* parallel in perceptual space are found to be convergent, when more than three dimensions are brought into consideration; but that proves not that a fundamental axiom of thought (that things cannot both be, and not be, at the same time) is wrong, but only that our senses deceive us.

I write as a representative of the ignorant crowd. I have a notion (founded not on knowledge, for the higher mathematics are beyond me, but on hearsay) that mathematicians have reached their conclusions by taking space of more than three dimensions into account. I cannot perceive such space, and therefore cannot imagine it, and I am sure that no mathematician is better able. We can imagine only in terms of the senses which we have already used. Because I have seen, I am able to picture a dragon such as was never yet on land or sea. But a congenitally deaf man has no conception of sound, and one who was born blind thought that scarlet was like the sound of a trumpet. Since our senses do not reveal more dimensions than three, we can gather no clearer conception of four or more than the congenitally blind or deaf have of sight or sound. Nevertheless, on production of evidence, we may believe in these inconceivable dimensions just as the blind or deaf believe in sight or sound.

Doubtless many aspects of reality are outside the range of our senses. If I am right as to what mathematicians have been at, all this seems simple. If, by taking more than three dimensions into account they have been able to predict truths hitherto unknown to us, then we must accept their evidence, and believe, for example, that lines that seem straight or parallel to us are not really so. But the work of mathematicians is one thing; the work of those who expound it to the ignorant is another thing. For example, it is one thing to say that the straight or parallel lines of our perceptions are not really straight or parallel; but quite another thing to declare that space itself is curved, and therefore that straight lines curve and parallel lines meet. In other words, it is one thing to say that our senses are defective, and another thing to announce that contradictory statements are both true.

G. ARCHDALL REID.

20 Lennox Road South,
Southsea, Jan. 11.

ON page 84 of NATURE for Jan. 19, Mr. McLennan expresses polite surprise that I allow myself to accept results, even on good evidence, which are repugnant to uninstructed common sense, or in other words, which run counter to the prejudices born of lifelong experience. Unfortunately, it has been my lot to come across phenomena so superficially alien to common sense that they are not acceptable to the scientific world, though they nevertheless presumptuously occur. Apart from those untoward happenings, however, and on more ordinary lines, we have to admit that common sense is not always a trustworthy guide in the face of evidence to the contrary. Even 1 and 1 are not always 2 when the units are concrete things, especially when the element of time is allowed to function. If they are mercury globules, in a little while the result may be still 1; whereas if they are amœbæ the result may be 4. Simple addition is not always the correct rule for compounding quantities; any more than the rule-of-three need be valid when simple proportion is not guaranteed.

The compounding of two velocities certainly looks as if it should be done by simple addition; but we must remember that the speed of a body moving on the earth is not an absolute or complete specification. Something has been ignored. Both bodies are moving through space: and space (or ether) has an unknown constitution. It is certainly afflicted with something which poses as a constitutional velocity,—a constant which declines to be ignored in extreme cases, and which we call c. So our ordinary velocity v may more strictly or fully be specified as v/c, for it is a fraction of the fundamental velocity in space. Hence when compounding u/c with v/c, to get the result w/c, simple addition turns out to be insufficient; the product uv/c^2 is involved as well. Many a schoolboy has found, to his chagrin, that $\tan(a+b)$ must not be written down as $\tan a + \tan b$, but that the product $\tan a \tan b$ is involved as well. That velocities ought to be compounded in this semi-trigonometrical fashion is not the least obvious, but that the fact is so may be intensely important; for it suggests that in space there is something rotational, which makes no appeal to the senses and can be ignored by engineers and practical people, though it may not be ignored by physicists.

To take another example. The velocity of light in stagnant water is c/μ, and if the water is flowing in the same direction with velocity v, common sense might say that the resultant velocity of the light should be $c/\mu + v$; but that is not what Fizeau found to be true. He found experimentally, what Fresnel had previously predicted, that v/μ^2 must be subtracted from the sum in order to give the true result.

All these queer rules of composition follow from the Larmor-Lorentz transformation, which was invented some years before relativity was heard of; though it was Einstein who seized the idea, boldly reclaimed it from abstraction, and applied it to actuality, in spite of the strangeness and apparent absurdity of some of the results. Would that science generally might gradually perceive that occurrences apparently preposterous may nevertheless be true! The universe is regulated by sense, no doubt, but not by common sense or uninstructed prejudice.

In conclusion, I quite sympathise with Mr. McLennan, and indeed with the others, in their temporary bewilderment. Odd results ought not to be accepted too cheaply.

OLIVER LODGE.

Normanton House,
Lake, Salisbury, Jan. 20.

MR. McLENNAN says (NATURE, Jan. 19, p. 83) that $V + v = V$ is incompatible with common sense. Is $P + \rho = P$ equally incompatible, where ρ is density: and is he forced to believe that the density of a mixture must always be greater than that of either of its components? Doubtless he will say, No. If he will consider very carefully why he thinks velocity, but not density, must be additive, he will probably arrive at a solution of his other difficulties.

N. R. C.

An Iodine Liberator from Laminariæ.

AN aqueous extract of fresh fronds of Laminariæ will, when acidulated, liberate iodine from potassium iodide.

This fact, recently observed by me, does not seem to have been previously recorded. It suggests an explanation of the process by which marine algæ

collect comparatively large quantities of iodine from the sea water in which it occurs in such low concentrations. It seems possible that at certain parts of the plants or at certain times of the year a sufficient acidity is developed to enable this iodine-liberating body to act on the inorganic iodides in the sea water which is in contact with the fronds. The iodine thus liberated would then combine with unsaturated bodies in the plants. According to this theory, the inorganic iodides which are found in the plants would of course be secondary products of metabolism. The existence in various varieties of algæ of unsaturated acids which would serve for the absorption of the free iodine has recently been demonstrated by Tsujimoto (*Chem. Umschau*, **32**, 125; 1925).

The presence of an iodine liberator would also furnish an explanation of the observations of Freundler, Menager, and Laurent (*Compt. rend.*, **173**, 1116; 1923) on the loss of iodine by seaweeds on drying. During the drying, acidity probably increases to the point at which the iodine liberator can act.

The iodine-liberating solution is easy to obtain. In my experiments the fronds of *Laminaria digitata* or *Laminaria saccharina*, freshly gathered from the seashore, where they had been thrown up by the tide, were minced in an ordinary mincing machine, treated with their own weight of distilled water containing a little toluene (5 c.c. per litre) to arrest bacterial action, and left standing for about twenty-four hours. The liquid was poured off through a Buchner funnel (without filter paper), and this liquid, on treatment with a little hydrochloric or acetic acid and a solution of potassium iodide, gave a pink colour on shaking up with carbon disulphide. The pink colour may sometimes be observed without the addition of potassium iodide, sufficient iodides being already present in the solution. The addition of potassium iodide, however, seems to intensify the colour.

When the solution was placed in a parchment filter which was immersed in distilled water for a few days, the iodine-liberating property was found in the outer liquid. In fact, this dialysed product appeared to be more active than the original extract.

Boiling does not appreciably impair the iodine-liberating power of the solution. This fact, together with its property of dialysing through parchment, pointed to the possibility that the active agency consisted of ferric ions. The solution does not give a pink colour with potassium thiocyanate, but I have found that concentrations of ferric chloride which give a doubtful response to this test will when acidulated liberate easily detectable quantities of iodine. When 25 c.c. of the solution were evaporated to dryness and ignited and the resulting ash dissolved in 2 c.c. of dilute hydrochloric acid, this solution gave a pink colour with potassium thiocyanate. Iron is therefore present, but only in such concentration that if it exists as ferric ions, the liberation of iodine by it would be very slow.

Any theory that inorganic ions are responsible for the iodine-liberating activity of the liquid seems, however, to be ruled out by the following experiment. 25 c.c. of the dialysed product were evaporated to dryness in a beaker on a piece of wire gauze, and carefully heated until the yellow residue began to turn brown. This residue was then dissolved in dilute hydrochloric acid and the solution was made up to about 24 c.c. (a little less than the original volume). The solution thus obtained did not liberate iodine.

From the observations so far made, the iodine-liberating agent would appear to be a dialysable organic body. Further study of the substance is in progress. In the meantime it should be of interest to try whether such a body can be detected in the thyroid gland. In this connexion I should mention that while I have never had any difficulty in obtaining an iodine-liberating extract from Laminariæ, in my only experiment with *Fucus* (which contains a much smaller percentage of iodine) I failed to obtain it. If an iodine liberator exists in the thyroid gland, its detection will be by no means so easy as in the case of Laminariæ.

THOMAS DILLON.

Chemical Laboratory,
University College, Galway.

Dissociation of Hydrogen by Collisions of the Second Kind.

HEITLER and London have calculated the potential energy of the ground state of H_2, and they have found besides the known 1^1S state, another potential energy curve which is called by them 1^3S. This curve is higher than the 1^1S curve by an amount equal to the heat of dissociation of the hydrogen molecule. Stuckelberg and Winans have used this curve to explain in a very nice manner the continuous spectrum of the hydrogen molecule. Their explanation, in brief, is that transitions from any one of the excited triplet levels to this 1^3S level give rise to a continuous spectrum.

It is the purpose of this short note to direct attention to the application of this new level to the interpretation of the Cario and Franck experiment on the dissociation of molecular hydrogen in a mixture of hydrogen and excited mercury atoms in the 2^3P_1 state. The usually accepted interpretation is that the energy of excitation of the mercury atom goes into an increase in the vibrational energy of the hydrogen molecule, and since the energy of the mercury in the 2^3P_1 state is more than sufficient to dissociate the molecule, enough energy of vibration is acquired during the collision to dissociate it. Other explanations have been suggested, such as the possibility of a chemical combination taking place between the excited mercury atom and the hydrogen molecule and subsequent dissociation ensuing. It is possible now to propose still another interpretation for the Cario and Franck experiment. The explanation is, briefly, that the result of a collision between an excited mercury atom and a normal hydrogen molecule is the excitation of the molecule from the 1^1S to the new 1^3S level. Since the potential energy curve in this level possesses no minimum, it is an unstable state and immediate dissociation results.

The question arises as to the probability of such a transition occurring. Since 11·5 volts is very close to the height of the 1^3S curve over the 1^1S curve at the nuclear separation corresponding to the minimum of the 1^1S curve, it is quite clear that for electron impact the most probable transition is one corresponding to nearly this energy. This is simply in accordance with the Condon theory of band intensities, and in terms of the potential energy diagrams for the two levels it means that the most probable transition is a vertical one. Elsewhere, Dr. Kinsey and I have directed attention to evidence which points to the fact that in collisions of the second kind between excited entities and diatomic molecules, diagonal transitions are very probable (*Physical Review*, Abstract in press). We have here, therefore, another phenomenon that provides evidence for the truth of the above statement that it is possible to cause diagonal transitions in collisions of the second kind, whereas in electron impact the most probable transitions are vertical ones.

This interpretation of the Cario and Franck experiment requires that dissociation of hydrogen should occur by collisions of the second kind with atoms or

molecules that possess energy greater than the energy of dissociation. It does not follow any longer that dissociation will be most probable when the energy of the excited entity is most nearly equal to the dissociation energy. The most probable conditions for dissociation will now be determined by the most probable jump between the two potential energy curves for the 1^1S and 1^3S levels.

This explanation of the Cario and Franck experiments does not, without further discussion, rule out the explanation that the energy goes directly into vibrational energy in the normal 1^1S level. This question of the transfer of energy from electronic to vibrational energy will be considered in a future communication.

JOSEPH KAPLAN.

Department of Physics,
University of California,
Los Angeles, California.

Microseisms associated with Storms in the Indian Seas.

THE ground is never at rest, and a seismograph provided with an aperiodic pendulum and a large magnification will always record these ever-present movements. The types are often so complicated that it is not easy to distinguish those associated with definite weather disturbances. To obviate these difficulties, a Milne-Shaw seismograph was installed some four years ago in the underground constant temperature room of the Colaba Observatory, and its working condition was so arranged that it should just cease to record microseisms when the weather was undisturbed over the neighbouring seas, as in the months of January and February, when the wind velocity seldom exceeds 20 miles per hour over the sea areas. It was then noticed that microseisms made their appearance in the records whenever weather was disturbed over the Arabian Sea or the Bay of Bengal, so as to cause rough seas over a fairly wide area. In particular, three distinct types of microseisms were recognised, and these were associated with (1) the south-west monsoon, (2) the storms in the Arabian Sea and the Bay of Bengal, and (3) local disturbances, such as pronounced land and sea breezes. Those associated with the south-west monsoon are steady vibrations, having periods varying from 4 to 10 seconds, according to the strength of the air current over the sea.

The periods and the amplitudes of these movements are easily explained theoretically if they are considered to be standing vibrations on the earth's surface, combining to form progressive waves, analogous to Rayleigh waves, produced and maintained by the sea-waves generated by the monsoon currents. The microseisms associated with storms have periods varying from 4 to 6 seconds and show typical irregular variations in amplitude owing to superpositions of waves of different periods arising on account of the existence of a marked difference in wind velocity in the storm and surrounding areas. They make their appearance in the seismograms as soon as a storm has formed, and disappear only after it has passed inland and ceased to affect the sea.

The types are readily distinguished, and thus throw open to the meteorologists a new method of forecasting the existence of storms. The amplitudes of microseisms are found to be a function of the distance and the intensity of the storms. For example, the microseisms developed by the storm in the Arabian Sea, which crossed the coast between Bombay and Ratnagiri on Nov. 12, 1927, had amplitudes about four times larger than those due to a storm in the Bay of Bengal, which crossed the coast near Nellore ten days before, but the types were identical.

During the pre-monsoon and the post-monsoon periods, when the records are almost free from monsoon microseisms, the formation and the early development of a storm are easily recognised by the gradual appearance of feeble microseisms of variable amplitude, which become more and more marked as the storm is fully developed. During the four years the instrument has been in operation, several storms formed in the Arabian Sea and the Bay of Bengal, and all of them gave rise to microseisms of this kind from the time of their formation until they passed inland and ceased to disturb the sea.

The microseisms associated with a local disturbance have large periods, varying from 20 to 30 seconds, and appear to be caused by waves over the shallow sea near the coast, for such waves have periods of exactly this order. They are certainly not due to the shaking of buildings and trees by gusts of wind, for such shakings will cause vibrations, which in an ordinary building will have periods less than 0·1 sec. A detailed account of these investigations is now ready and will be shortly published.

S. K. BANERJI.

The Observatory, Bombay,
Nov. 30.

Refraction of Beams of Molecules.

IN the Stern-Gerlach experiment the deviation of a beam of molecules in a magnetic (or electric) field is comparable to the optical case of the refraction suffered by a beam of light in traversing a medium, the refractive index of which varies in a direction perpendicular to the beam; the variation of the refractive index being analogous to the force or gradient of the field. However, in optical instruments the standard method of obtaining refraction is to allow the beam to travel from a homogeneous medium of refractive index n_1 to another of refractive index n_2. The total refraction is then independent of the rate of variation of refractive index in the interface.

It is of interest to follow out the obvious analogy for a molecular beam. In the diagram, a beam of

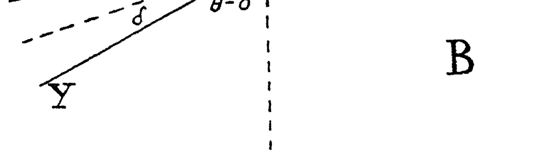

FIG. 1.

molecules XO passes from a region of no magnetic field A to another region B in which obtains a homogeneous magnetic field H perpendicular to the plane of the paper. Such a field can be produced between the flat pole pieces of a magnet. Let the beam be in the plane of symmetry between the pole pieces. We consider for simplicity a beam of alkali atoms in the normal state with kinetic energy E. The atoms will be orientated parallel or anti-parallel to H.

Since there is no component of the force parallel to the edge of the pole piece, we have as in the optical case,

$$\sin(\theta - \delta)v_B = \sin\theta v_A,$$

$$\frac{\sin\theta\cos\delta - \cos\theta\sin\delta}{\sin\theta} = \frac{v_A}{v_B} = \frac{\sqrt{\dfrac{2E}{m}}}{\sqrt{\dfrac{2}{m}(E+\mu H)}},$$

where μ is the Bohr magneton.

Since δ is small

$$\delta = \left(1 - \frac{1}{\sqrt{1+\dfrac{\mu H}{E}}}\right)\tan\theta.$$

If the ratio $\mu H/E$ is small

$$\delta = \frac{\mu H}{2E}\,.\,\tan\theta.$$

For a distance l, the total deviation will be

$$\Delta = \delta l = \frac{\mu H}{2E}\,.\,l\tan\theta.$$

What is of experimental importance in the final equations is that the deviation depends on the value of the homogeneous field only, which enables one to dodge the serious technical difficulties involved in determining the inhomogeneity of a magnetic field in a small region.

As a numerical example: if l be 10 cm., $H = 10^4$ gauss, $\mu = 1$ Bohr magneton, $0{\cdot}92 \times 10^{-20}$ gauss cm., E the average energy for 0° C., and $\theta = 80°$ (app.), then Δ is approximately 0·5 mm., a conveniently measurable deflection.

The above considerations also apply to the case of an electric field; here a parallel plate condenser takes the place of the flat pole pieces. One can also generalise the above procedure and construct analogues of prisms, etc.

A complete discussion, including an experimental investigation, will be published in the *Zeitschrift für Physik*.

I. I. RABI
(International Education Board Fellow).
University of Hamburg.

Photochemical Union of Hydrogen and Chlorine.

SHORTLY before the close of 1927 we finished some experiments, which had extended over about two and a half years, on the photochemical union of hydrogen and chlorine. Circumstances have prevented publication until now, and may impose a still further delay. We therefore would wish to make known certain of our results, particularly as we think they will prove of interest to other workers in the same field.

Our attention was directed towards two main points—the effect of intensity and that of wave-length, using monochromatic light in both cases. With regard to the former, we need only say that our results are in agreement with those obtained earlier by Mrs. M. C. Chapman and with those published after the commencement of our experiments by Kornfeld and Steiner and by Marshall. The effect of wave-length on quantum efficiency was, however, surprising. We worked with moist electrolytic gas, employing the Bunsen-Roscoe technique and used the quartz-mercury lamp lines at (*circa*) 546, 436, 405, 365, 313, and 260 $\mu\mu$, separating these so far as possible by means of filters. Four of the latter let through less than one per cent of foreign light, and the only serious uncertainty arose with the filter for 260 $\mu\mu$. The incident intensities, as also the amount and nature of foreign light in the beams used, were determined by thermopile measurements, and the absorbed intensities calculated from the data of von Halban and Siedentopf. The result was that we found the quantum efficiency to rise from 546 $\mu\mu$ to 405 $\mu\mu$, and then, as the frequency was increased, to fall off to 260 $\mu\mu$. The actual (relative) figures are as follows:

Wave-length	260 $\mu\mu$	313 $\mu\mu$	365 $\mu\mu$	405 $\mu\mu$	436 $\mu\mu$	546 $\mu\mu$
Quantum efficiency	0·10	0·49	0·53	1·00	0·67	0·22

The figure for the first group of lines could only be determined very roughly, but certainly did not exceed fifty per cent of that obtained for the same gaseous mixture, with practically monochromatic 436 $\mu\mu$ radiation. The sensitivity of the gas used in the various experiments corresponded to a yield of the order of 200,000 molecules of HCl per quantum of blue light absorbed. It showed no induction period, but gave a marked Draper effect during the first instants of insolation.

Experiments carried out at 19·7° and at 25° showed the relative temperature coefficients of the quantum efficiency to increase slowly, but unmistakably, with wave-length between 313 $\mu\mu$ and 436 $\mu\mu$. Other experiments in which two 'monochromatic' beams were allowed to act simultaneously gave a velocity equal to the sum of their separate effects, in disagreement with work of Padoa, but in agreement with the conclusion to be drawn from the experiments on the effect of intensity.

It is difficult to explain our main results without recourse to *ad hoc* hypotheses, of which we have considered many. To two points, however, we would direct attention. The relative efficiencies found for the 436 $\mu\mu$ and 260 $\mu\mu$ rays are in agreement with the experiments of Heymer (1927), whilst the definite effect of the mercury green line (most workers seem to assume, on insufficient experimental evidence, that it would be inactive) is in accord with recent work of W. Taylor.

Further experiments, using spectrally dispersed light, are now being started in this laboratory.

A. J. ALLMAND.
EDWARD BEESLEY.

Chemical Department,
King's College,
London, W.C.2,
Jan. 21.

Diffraction of Electrons at Ruled Gratings.

IN June of last year (*Proc. Phys. Soc.*, vol. 40, p. 284) I made a preliminary announcement of an experiment on the diffraction of electrons from a ruled grating in much the same way as has been done with X-rays. In a recent publication summarised in NATURE of Jan. 5, p. 29, E. Rupp has published results of an investigation on this subject, using a method very similar to my own, in which he obtains diffraction images on one side of a reflected line, which yield a value of the equivalent wave-length in good agreement with the de Broglie value. In view of the immediate interest in experiments of this type, I give below the results of a preliminary experiment which I obtained in December last.

Electrons from a coated filament were 'collimated' and sent at a glancing angle of the order of 1° on to a ruled grating (speculum). A series of experiments verified that electrons, but no light, were falling on the grating, and a photographic record was obtained which clearly showed a diffracted line on *both sides* of the direct reflected line. Any doubt as to this

being due to secondary X-rays from the slits, etc., was eliminated, as a simple calculation shows that 1300 volts were necessary to produce X-rays corresponding to the upper limit assigned to the observed pattern, whereas the maximum accelerating voltage applied from accumulators did not exceed 85 volts.

The photograph is not ideal for reproduction or precise calculation, but the diffracted lines are clearly visible to the eye and show an assymmetric displacement about the direct reflected line, as is anticipated from theoretical considerations. These points are seen in the accompanying diagram (Fig. 1) which

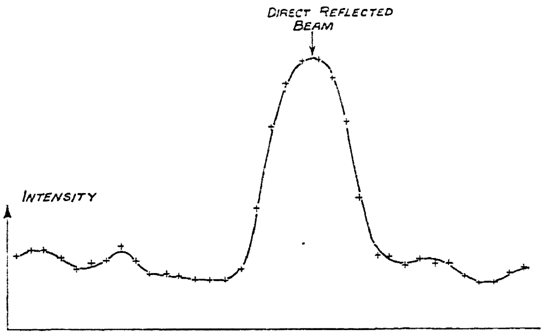

FIG. 1.

shows the result of a photometric examination of the plate, kindly made by Dr. W. H. J. Childs.

The results differ from those of Rupp inasmuch as there are diffracted images at both sides of the reflected line. This is to be anticipated from general considerations of diffraction, and in the X-ray case Compton and his school obtain a similar effect.

The ordinary optical formula for a grating, when using small glancing angles, θ, reduces to

$$n\lambda = \frac{d\alpha}{2}(2\theta - \alpha)$$

where α is the angle between the reflected and the diffracted line and d is the grating element. Clearly, when $\alpha = \theta$, a limit is reached, which shows that when θ is less than $\sqrt{2\lambda/d}$ no diffracted line will occur on the small angle side of the reflected beam. Rupp uses very small angles, θ, and his one-sided diffracted system is therefore explained on these lines.

These experiments are still in progress, and I hope to make an early announcement of more results, and a description of the experimental details.

B. L. WORSNOP.

Wheatstone Laboratory,
King's College,
London, W.C.2, Jan. 19.

The Refractivity of Gaseous Compounds.

SOME simple relations appear to exist between the refractivities of a number of gaseous compounds and their constituents in the gaseous state which, so far as I know, have not hitherto been published. The refractivity of an atom depends largely on the outer electrons which are loosely bound to the nucleus. Previously it has been considered that when combination occurs between atoms the outer electrons are so distorted that the refractivity of a molecule is not related in any simple way to the refractivities of the constituent atoms and that the deviation from an additive law is a measure of the distortion (cf. Fajans and Joos, *Zeit. f. Phys.*, vol. 23, p. 1; 1924; Born and Heisenberg, *Ibid.*, vol. 23, p. 388; 1924; Havelock, *Phil. Mag.*, vol. 3, pp. 158, 433; 1927).

The following simple relations have been observed. If $(\mu - 1)_R$ is the refractivity of the substance R, *in the gaseous state*, under normal conditions as defined by Cuthbertson (*Phil. Trans. Roy. Soc.*, vol. 204, p. 323; 1905), where μ is the refractive index, then

$$\begin{aligned}
(\mu - 1)_{HCl} &= \tfrac{4}{7}(\mu - 1)_{Cl_2} \\
(\mu - 1)_{HBr} &= \tfrac{13}{25}(\mu - 1)_{Br_2} \\
(\mu - 1)_{CCl_4} &= \tfrac{16}{7}(\mu - 1)_{Cl_2} = 4(\mu - 1)_{HCl} \\
(\mu - 1)_{CS_2} &= \tfrac{4}{3}(\mu - 1)_{S_2}.
\end{aligned}$$

The ratios ($\frac{4}{7}$), ($\frac{13}{25}$), ($\frac{16}{7}$), and ($\frac{4}{3}$) are closely related to the number of loosely bound electrons, which in Cl_2, HCl, CCl_4, S_2, and CS_2 are assumed to be the M electrons and in Br_2 and HBr the M and N electrons. If the chlorine atoms in HCl and CCl_4 and the bromine atom in HBr are singly ionised, and if the sulphur atoms in CS_2 are doubly ionised, then Cl_2 contains fourteen loosely bound electrons, HCl eight, CCl_4 thirty-two, S_2 twelve, CS_2 sixteen, Br_2 fifty, and HBr twenty-six. It is seen that the ratios between the numbers of loosely bound electrons are the same as the ratios between the refractivities.

This way of regarding the problem is obviously much too simple and is applicable in only a few cases. In general, relations of the kind given above do not appear to exist between the refractivities of substances in the gaseous state. It is, indeed, surprising how well the simple relations hold for HCl, HBr, CCl_4, and CS_2. In Table 1, results are given for HCl, and Cl_2 for a series of wave-lengths λ.

TABLE I.

λ.	$(\mu - 1) \times 10^8$.			Percentage Difference between (2) and (3).
	(1) $(\mu-1)_{Cl_2}$.	(2) $(\mu-1)_{HCl}$.	(3) $\frac{4}{7}(\mu-1)_{Cl_2}$.	
6707·8	77,563	44,375	44,320	−0·1
6438·5	77,703	44,444	44,400	
5790·5	78,121	44,656	44,640	
5769·5	78,135	44,666	44,648	
5460·7	78,400	44,800	44,800	0
5209·1	78,651	44,930	44,944	
5085·8	78,791	45,007	45,024	
4799·9	79,166	45,187	45,240	+0·1

It is intended to give a more detailed account of this work soon, together with some general observations on the refractivities of other gaseous compounds.

G. W. BRINDLEY
(Darbishire Research Fellow).
University of Manchester,
Dec. 28.

Palæolithic Pottery.

IN NATURE of Jan. 19, p. 104, it is stated, in reference to Mr. Leakey's discovery in Kenya of pottery associated with an Aurignacian industry, that nowhere else does pottery occur at so remote a period.

There are, however, on record certain discoveries which go to show that this statement perhaps needs modification. These are—

1. The finding, in the cultural layer immediately overlying that in which the famous Neanderthal skeletons of Spy were unearthed, of the bones of "fossil animals, also those of a few living species,

several thousands worked flints, some of which still of the Mousterian type, many worked bones, including arrow points, and also fragments of pottery."[1]

2. The discovery, in several caves in Belgium, of the remains of pottery in Upper Palæolithic deposits.[2]

3. The finding, by me, in a small valley to the north of Ipswich, of fragments of pottery, of a hitherto unknown type[3] associated with flint implements of Upper Mousterian or Lower Aurignacian forms, in a geological deposit of manifest antiquity. In regard to this latter discovery, I may say that it was by no means easy to recognise, at first, that the fragments of what looked like charcoal in the geological deposit mentioned were indeed pieces of pottery, and it was only by a very careful examination that this recognition was made possible.

Personally, so small a value do I place upon the making of primitive pottery as an indication of the advancement and capabilities of any prehistoric people, that it would not surprise me to hear of its discovery in, for example, a 'floor' of Late Acheulean age.

It is, of course, possible, for those who do not believe that Palæolithic man made pottery, to deny that any of the discoveries I have enumerated are of Palæolithic age. But this claim carries with it the necessity of proving it to be true.

J. REID MOIR.

Ipswich.

Short Wave Echoes and the Aurora Borealis.

BOTH Prof. Appleton and Dr. van der Pol have suggested in letters in NATURE of Dec. 8 that the echoes observed by Prof. Størmer with delays of about ten seconds might be explained by the disturbance spending a long time in a region containing so many electrons per c.c. that the group velocity of the disturbance was very small.

The effective dielectric constant ϵ and conductivity σ of a region containing N free electrons per c.c. for waves of frequency $\omega/2\pi$ are given by $\epsilon + \frac{4\pi\sigma}{i\omega} = \frac{3+2\alpha}{3-\alpha}$, where $\alpha = -\frac{4\pi N e^2}{m(\omega^2 - if\omega)}$; f measures the rate at which the velocity of the electron becomes uncorrelated with its initial velocity, so that $f = v/l$ where v and l are the velocity and effective free path of the electron. The condition that the group velocity is zero is that $\epsilon = 0$, *i.e.*, since $f \ll \omega$, $N = 3m\omega^2/8\pi e^2 = 1\cdot9 \times 10^6$ electrons per c.c. for wave-length 30 metres (Dr. van der Pol, *loc. cit.*, using the formula valid for small α, obtains $N = 10^6$).

Even if the atmospheric pressure is very low, so that collisions with atoms contribute little to f, a minimum value of f, for given N, is fixed by the effects of the electrostatic forces between the electrons, and between the electrons and other ions. A calculation I have recently made (*Proc. Roy. Soc.*, A, vol. 121, p. 464) gives the following approximate formula for the effective mean free path in such circumstances,

$$l = 3v^4 \Big/ 4\pi\left(\frac{2e^2}{m}\right)^2 N \log\left(3v^6/4\pi\left(\frac{2e^2}{m}\right)^3 N\right).$$

Assuming $v = 1\cdot2 \times 10^7$ (P. O. Pedersen, "The Propagation of Radio Waves," p. 44), we obtain $l = 4\cdot8 \times 10^2$ cm., $f = 2\cdot5 \times 10^4$.

For a delay of t seconds the signal intensity is reduced to $e^{-ft/2}$ of its initial value (Prof. Appleton, *loc. cit.*), that is, for a delay of 10 sec. to $e^{-125{,}000}$. The suggested explanation seems, therefore, to be untenable, unless it is assumed that v is much larger. If v were 30 times as large ($v = 3\cdot6 \times 10^8$, corresponding to 37 volts) the minimum reduction for a 10 sec. delay would be to $e^{-4\cdot6}(=1/100)$ of its initial value.

The above objection does not apply to the second explanation put forward by Prof. Appleton.

L. H. THOMAS.

Trinity College,
Cambridge, Jan. 14.

[1] Hrdlicka, *Annual Report of the Smithsonian Institution*, 1913, p. 522.

[2] *Bull. Soc. préhist. de France*, 1907–8 (two papers).

[3] "Antiquity of Man in East Anglia" Camb. Univ. Press, p. 87, Fig. 35.

Oiling of Plates for Ultra-violet Photography.

IT has long been known that a substitute for the Schumann plate for ultra-violet spectroscopy beyond 2500 A. can be made by oiling the surface of the plate. These oiled plates were found by Harrison (*Jour. Optical Soc. Amer.*, vol. 11, pp. 113 and 341; 1925) to be in some respects superior for photometry, as Schumann plates are rather uneven, having spots of greater sensitivity. All the methods so far suggested for oiling the plates are rather messy and involve the cleaning of the plate before development. There is also a loss of sharpness due apparently to the thickness of the oil coating. The following method used by me seems to overcome these disadvantages and may be of interest to other workers in the subject. I use a filtered solution of 5 grams of vaseline in a litre of petroleum ether. The quantity of vaseline may be increased for certain work. The plates are flooded with this solution in a dish and lifted out and rapidly dried. After exposure they can be developed without further treatment by the 'stand method.'

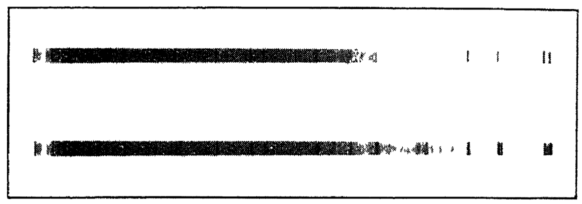

FIG. 1.

The accompanying photograph (Fig. 1) is of the aluminium condensed spark from the visible to 1830 A. The exposure was 15 sec. in each case on a Wellington anti-screen plate. The first exposure was made, the plate was then flooded with the 0·5 per cent solution three times, being dried between each. The second exposure was then made and the plate developed in glycin.

A. CHRISTOPHER G. BEACH.

Chelsea Polytechnic,
London, S.W., Jan. 7.

Raman Lines from Hydrochloric Acid Gas.

(BY CABLE, THROUGH SCIENCE SERVICE, WASHINGTON, D.C.)

BY employing a long end-on tube excited by a parallel Cooper Hewitt mercury arc with aluminum reflectors, I have obtained the modified lines of gaseous hydrochloric acid at atmospheric pressure corresponding to the vibration–rotation absorption band at $3\cdot6\ \mu$, a double line with indications of fine structure. Improved technique is expected to permit higher dispersion.

R. W. WOOD.

Jan. 28.

The Mechanism of the Nerves.[1]

By Prof. E. D. ADRIAN, F.R.S.

THE nervous system is a mass of living cells which has the extraordinary property of appearing to influence and be influenced by the mind. It is a material system somehow responsible for such non-material things as emotions and thoughts. These are in a category outside the range of mechanical explanation, and for this reason the working of the nervous system will never be fully explainable in terms of physics and chemistry. But some of the processes which take place in it can be treated in this way, and there will be no need to alter our methods of approach until we have gone a great deal further by the recognised routes. These routes are many, and the present article deals with only one of them. It deals with the analysis of the messages which travel along the nerve fibres—an analysis made possible by the recent development of the triode valve amplifier.

The active elements of the nervous system consist entirely of cells giving off fine thread-like extensions of protoplasm. These make up complex interlacing fibres forming the grey matter of the central nervous system, but most nerve cells give off one thread much larger than the rest (the axon), and this forms the channel of communication between the cell and the more distant regions. It may lead to other parts of the central nervous system or it may pass outside and lead to a sense organ or to a group of muscle fibres or secreting cells. At a short distance from the cell the axon develops a fatty sheath, and outside the central nervous system it is protected by an external covering of tubular cells, the neurilemma. The whole forms a nerve fibre with a diameter ranging from 2 to 20 microns and a length which (in man) may exceed one metre. The peripheral nerves are made up of bundles of these fibres having a common area of distribution, the number of fibres in a nerve trunk often running into several thousand. The communicating tracts of the central nervous system are similarly constituted.

We have known for some time that a nerve fibre can conduct a particular type of message under artificial conditions. A special branch of physiology has been occupied for a hundred years in investigating the changes which take place in a frog's nerve and muscle isolated from the body and stimulated mechanically or electrically. If the nerve is pinched, or if a current is passed through a short length of it, the muscle contracts. Some disturbance has passed down from the stimulated region of the nerve, and this is able to make the muscle develop its normal activity. In a frog's nerve the disturbance, or 'nervous impulse,' travels at the rate of 20-30 metres a second. No visible change accompanies it. The thermal changes are so small that it is only in the last few years that A. V. Hill has been able to detect them, and the chemical changes can only be studied by repeating the stimulation over long periods so as to obtain a measurable result.

One accompaniment of the impulse is more readily detected, however, and this is the electric response or 'action current.' Whenever the impulse arrives in a particular section of the nerve, a change of potential is developed between the active and the neighbouring inactive parts, and a current flows through the fluid surrounding the nerve or through a galvanometer connected to the active and inactive regions. As the active region travels down the fibre, the current flows shift with it, and this electric charge accompanies the impulse whatever form of stimulus is applied to the nerve. The electric charge is small enough—when every fibre in the nerve is in action simultaneously, the potential change is of the order of 10 millivolts, and the whole thing is over in a few thousands of a second. But it can be detected by instruments like the string galvanometer or the capillary electrometer, which combine sensitiveness and high periodicity, and it has given us a great deal of our information about the nature of the impulse.

Briefly, we find the impulse to be a momentary disturbance, the intensity of which at any point is determined entirely by the condition of the fibre at that point. Stimulating the nerve may be compared to firing a gun: we may pull too feebly on the trigger, but if we pull hard enough to fire the bullet no amount of extra pulling will make it travel any faster. In the same way we cannot regulate the intensity or rate of travel of the impulse by regulating the stimulus. Again, the gun needs reloading before it can be fired again, and in a nerve fibre, the passage of an impulse is followed by a very brief interval during which a further stimulus is ineffective. Each impulse is a discrete change with definite time relations, and there can be no continuous activity in the fibre, but only a succession of impulses.

The impulse takes place in a highly complex system, and no doubt it involves a whole succession of reactions which will take many more years to unravel. But it seems fairly clear that one of the principal events is the passage down the fibre of a wave of surface change which allows an interchange of ions to take place between the interior and the exterior in the active region and so to give rise to the action current. Rapidly spreading surface changes are known in many inorganic systems, and R. S. Lillie has developed a model which presents an extraordinary close analogy with the nerve fibre. When an iron wire is immersed in strong nitric acid, its surface becomes coated with a layer of 'passive' iron (probably an oxide), which prevents the acid from acting any further. If the film of passive iron is destroyed at any point, the difference of potential between the active and passive iron produces a current which has the effect of destroying the passive film

[1] Substance of two lectures delivered at the Royal Institution on Nov. 22 and 29.

in the neighbouring section of the wire, and at the same time restores it where it was first destroyed. Thus the area of surface change spreads down the wire, accompanied by an electric change which is a close copy of the action current in a nerve. Moreover, the iron wire model, like the nerve, can be stimulated by electrical as well as mechanical means.

We are still very far from knowing all that goes on when an impulse passes down a nerve fibre, but at least it has none of the variability we might expect, and we seem to be dealing with a definite series of changes following one another with mechanical regularity, changes which can be made to repeat again and again, yielding similar measurements whenever we have instruments sensitive enough to record them.

Unfortunately, the changes are so small that even the electric response can only be recorded directly when all the fibres in a nerve trunk are acting simultaneously. In the body they act more or less independently, and until recently we could not even be certain that the disturbances transmitted from sense organs or nerve cells might not differ considerably from those studied in the isolated muscle and nerve preparation. But the whole position has been altered by the advent of the triode valve amplifier. It is now possible to magnify the smallest and briefest electric changes until they are large enough to affect a recording instrument chosen not for its sensitiveness, but for its ability to give a true rendering of the most rapid fluctuations of current. The delicate string galvanometer may be replaced by the insensitive capillary electrometer, by the moving iron oscillograph recently developed by Matthews, or even by the cathode ray oscillograph used for physiological work by Erlanger and Gasser. In fact, if electric changes do occur in the normal working of the nervous system, we can no longer complain that they are too small to measure.

With the aid of valve amplification it is very easy to show that the messages which pass into or out of the central nervous system are accompanied by rapid fluctuations of potential in the nerve trunk. This, and indeed almost all the features of the nervous messages, can be demonstrated to a large audience by converting the amplified potential changes into sound waves with a loud speaker. A small piece of skin from the frog with the attached cutaneous nerve is set up in a stand with electrodes leading from the nerve to the amplifier input, and whenever the skin is touched, the nervous message set up by the sense organs in the skin becomes audible as a crackling sound in the loud speaker.

This by itself tells us very little about the nature of the message in each nerve fibre, for we are recording the confused effect of a number of fibres acting independently. To restrict the activity to one fibre we have either to divide all but one of the active nerve fibres (a difficult but not an impossible undertaking) or to arrange that the stimulus shall affect only one end organ. The former method has been used for studying the messages sent by the motor nerve cells to the muscles and the latter for the messages from sense organs. The results then become very clear and very simple. To deal first with the sensory message, we find that it consists of a series of impulses quite indistinguishable from those produced by artificial stimulation. These recur fairly regularly at a frequency which varies between 5 and 150 a second. All the impulses are alike, but the frequency with which they recur depends on the intensity of the stimulus to the sense organ. This is true of all the sense organs which have been investigated, although there are characteristic differences in the behaviour of different kinds of sense organ under a continued stimulus.

The changes in frequency will be enough to signal the intensity of the stimulus, but what is there to indicate its quality? There are two possible answers to this. One is that all the messages arising from a touch corpuscle produce sensations which we recognise as touch because they are conveyed by a particular nerve fibre and led through particular channels in the central nervous system. The other is that the impulses from different sense organs are in fact not exactly alike. The sensory nerve fibres differ considerably in diameter: Erlanger and Gasser have shown that the duration and rate of travel of the impulse varies with the diameter of the fibre, and Matthews has added the fact that sensory impulses produced by tension on a muscle travel faster than those produced by touching the skin. Whether there is a distinct size of fibre corresponding to every quality of sensation is uncertain, and it is equally uncertain whether the impulse will preserve a characteristic form as it travels through the terminal branches of the fibre, but, in the nerve trunk at least, the physiologist can tell from its form whether an impulse arises from skin or muscle, and the central nervous system may perhaps differentiate in the same way.

The investigation of the sensory message can be used to study the mode of action of the sense organs, and it can give precise information about the distribution and course of the sensory fibres, for example, in the viscera. A great deal remains to be done on these lines, but we must pass on to messages of a different origin.

The messages which pass from the motor nerve cells to the muscles are equally simple. They consist of impulses of the same kind spaced not quite so regularly, but covering very much the same range of frequency as the sensory impulses. The impulses which produce a feeble reflex or voluntary contraction recur at frequencies as low as 8-15 a second. With more intense excitation the nerve cells discharge at frequencies as high as 60-100 a second, and so produce a contraction of greater force. This agreement in the range of impulse frequency produced by the motor nerve cells and the various types of sense organ is the more striking when we remember the widely different structures involved.

Since all these messages are so much alike, we might reasonably expect to find that all the messages which pass to and fro in the tracts of the central nervous system are of the same type. For one case at least this can be verified. The optic nerve,

though it passes outside the central nervous system, is really a central tract connecting it with the retina, which is an elaborate nervous outgrowth from the brain. The messages which pass down the optic nerve when the eye is exposed to light are therefore one example of the type we might expect to find within the central nervous system. They are more difficult to analyse than those in the peripheral nerves, but there is little doubt that they consist of impulses discharged in fairly regular succession at a frequency which varies with the intensity of excitation of the ganglion cells of the retina and varies over much the same range as before. To generalise on one case may bring a speedy retribution, but it is hard to resist the conclusion that all the messages in the nerve fibres are of one type, with impulses spaced more or less evenly at frequencies which vary according to the urgency of the message.

Much remains to be done before we can be certain of this, and if the generalisation is correct we shall still be very far from knowing how the messages are generated and what determines the pathways through which they travel. The great controlling and co-ordinating stations of the central nervous system may work on lines far too complex to be analysed by methods available at the moment, but at least we can say that they receive their information and issue their orders in an extremely simple manner.

Forestry Research Work in France.

IN the *Annales de l'École Nationale des Eaux et Forêts et de la Station de recherches et expériences forestières* (Tom. 2, Fasc. 1, 1928), M. H. Perrin, of the Nancy Forest School, publishes an account of the past and present position of research work under the title of "Les recherches forestières en France." It is admitted in France that, in spite of the fact that Colbert initiated the first commencement of correct forest conservation so long ago as 1660, the necessity or utility of research work into forestry problems was not only neglected, but also its value was called in question by the executive and practical forest officers who managed the forests. Research, they considered, was pure theory, and had perhaps its correct place in the laboratory; but that its results could have any practical value out in the forests was regarded as chimerical.

In the light of the present-day acceptance of the unquestioned value and necessity of research work into forestry problems, the history of the question in France is not without interest. For two centuries its few advocates remained in the wilderness. A few obtained a partial hearing during their lifetime, but little advance was made in the practical routine methods, based on acquired practice, in force in the forests. Amongst these early enthusiasts were such men as Réaumur (1683–1757), Buffon (1707–1781), Duhamel du Monceau (1700–1782), and Varenne de Fenille (1700–1793), who put forward tentatively new methods of management which were regarded as interesting but unpractical. The next proposals, based on German forms of management and German doctrines, were introduced into France by four men, Baudrillart (1774–1832), Lorentz (1775–1865), Parade (1802–1865), and de Buffévent (1787–1860). The German ideas were considered too theoretical to be of any use in French forestry, which, so the experts maintained, depended not on experiments and research, but on the practical observations and experience of the men in charge of the forests.

The first weakening in this attitude was due to the work of two forest officers, the first products from the Nancy Forest School which was founded in 1825 to train the officers of the Government Forest Service on scientific lines. Between 1840 and 1850, these two men, Dessales de la Gibertie and E. Chevandier de Valdrôme, enunciated the theory that research work was essential if better and more abundant timber and other produce was to be obtained from the forests, and that a formal plan of forest research should be laid down. The ultra conservatism of the French forest regime was hard to break down, and the government showed no sign of having been converted. In 1861, A. Gurnaud resigned the French Forest Service in order to conduct a vigorous campaign in favour of a system of management which has since come to bear his name, and is used in the management of areas of forest in the Jura and in Switzerland.

Gurnaud's 'method of control,' as it was termed, was the subject of heated discussion over long years; but it may be regarded as having aroused the attention of French forest officers, and led them to consider whether their unquestioned acceptance of routine methods, long in force, was in the best interests of the forests. In 1873 a government circular was issued ordering the institution of sample plots of half a hectare in extent in the younger age classes in all State forests managed under the shelter wood compartment system—a system in wide usage in France. These plots were to be measured periodically. Unfortunately, no uniformity was prescribed as to the methods to be used in making the thinnings and calculating the resultant produce. Consequently, the value of the results attained was not uniform, and was of little use for general comparison purposes. It was a first step, however, in the recognition by government that research work might prove of value.

The next step in advance was the inauguration in 1882 of the Research Station at Nancy as an annexe of the Forest School, those responsible for the new departure rightly considering that instructional and research work should go hand in hand. In order to give effect to this idea, a certain number of forests adjacent to Nancy were placed under the management of the school and research centre. The Forest Nursery at Bellefontaine, a few kilometres from Nancy, was also made over to the school; and as time went on other forest areas were included in the school forests, as they are termed. The research officers were also permitted to make use of other neighbouring State forests for

research work. A gazetted assistant forest officer was attached to the Research Station, the professors of the school, mostly drawn from the Forest Service, being chiefly responsible for the research work.

In 1887 a committee was formed consisting of the director of the school, the professors responsible for research work, and the assistant forest officer. The committee drew up the programme of research work to be undertaken. This was a notable departure, but progress suffered from a want of funds, and to some extent from the lack of enthusiasm of the executive forest officers, by no means yet convinced as to the value of research work. It was admitted, however, that there were many problems to settle in connexion with the existing management, sylvicultural, technical, botanical, meteorological, and so forth. There were one or two breaks in the continuity of the work, but by 1914 the lines of research work had been more or less established under Bartet, Claudot, Jolyet, de Bouville, Guinier, and, lastly, Cuif. The latter had directed attention to the numerous problems awaiting solution, and the impossibility of carrying out useful work in the absence of adequate funds.

The War brought operations to an end, but in 1919, Cuif's representations were not lost sight of, and with the reopening of the station the government reorganised the management. The director of the school was placed in immediate charge, with a committee comprising the professors of the school and the conservator of forests stationed at Nancy. Research work was organised into four sections: (1) Sylviculture and forest economy; (2) botanical, including the physical and mechanical properties of timber; (3) zoology (entomology and pisciculture—the Forest Department is in charge of fishing in the rivers and its improvement by the rearing of young salmon and trout, etc.) and geology, comprising the study of forest soils; (4) work in connexion with the afforestation of denuded mountain slopes, erosion, and arrestation of dangerous torrents, and so forth. Assistants were attached to the professors in charge of these sections, and annual programmes were laid down by the committee.

The work of the research station concerns itself with the whole of France, but valuable help is now received by a network of what may be termed sub-research centres throughout the country, the investigations carried on at these sub-stations being entrusted to selected executive officers, who undertake special investigations in addition to their ordinary duties. Now that the value of research work has come to be fully appreciated by the executive officer, the central station has had no difficulty in inaugurating the local centres throughout the country. On this question Perrin writes: "Cette organisation d'annexes, nécessaire dans un grand pays où les conditions forestières varient à l'infini, paraît devoir rendre les plus précieux services; elle décharge la Station de Nancy d'une besogne matérielle considérable, tout en faisant rentrer les travaux des annexes dans un cadre commun qui permettra ultérieurement de les rapprocher; et, en même temps, elle assure aux praticiens qui veulent étudier de plus près certaines questions les directives et les subsides nécessaires."

The work of the last few years bears witness to the fact that in France, as elsewhere, the War, with its enormous demands on the forest, has impressed upon the government the recognition of the fact that forestry research work is essential if those forests are to be made to yield the maximum amount of produce the varying locality factors permit.

Obituary.

PROF. M. J. M. HILL, F.R.S.

BY the death of Prof. M. J. M. Hill, on Jan. 11, University College, London, loses one of the personalities that played a dominating part during the critical years which saw the rise of the new teaching University, and the University itself one of the most distinguished of its past *alumni* and teachers.

Micaiah John Muller Hill was the eldest son of the Rev. Samuel John Hill, and was born at Berhampore, Bengal, on Feb. 22, 1856, during the stormy days of the Indian Mutiny. He was educated at the school for the Sons of Missionaries, Blackheath, and entered University College as a student in October 1872. After a brilliant academic career in London he went up to Peterhouse, Cambridge, and in 1879 became Fourth Wrangler and Smith's Prizeman.

When only twenty-four years of age Hill was elected to the chair of mathematics at Mason College, as it then was,—now the University of Birmingham. In 1883 he became a fellow of Peterhouse, and in 1884 he was called to the chair of mathematics at University College, London, a post which he occupied until his retirement in 1924. He was elected a fellow of the Royal Society in 1894, and was an Sc.D. of Cambridge and hon. LL.D. of St. Andrews.

Hill's contributions to mathematics amount to nearly fifty papers, ranging over a wide field. In his earlier days he was much occupied with hydrodynamical problems, and his 'spherical vortex' has remained a classic. The duties of his chair, however, and his own peculiar bent, which prized in mathematics logic and rigour above all things, turned him eventually from applied mathematics, to which, to that subject's loss, he never returned.

Hill made up for this by increased activity in the domain of pure mathematics. To differential equations, in particular to the theory of singular solutions, he came back persistently; his last paper of this class dates from 1921. Another important group of researches deals with the theory of analytic continuation.

The subject to which Hill devoted himself specially during the last thirty years of his life, following in this his great predecessor, De Morgan, of whom

he was a fervent admirer, was the elucidation of Euclid's famous theory of proportion, which he can be said largely to have reconstructed. He was working at this almost to the very day of his death, struggling with amazing courage and success against the almost insuperable handicap of total blindness which overtook him suddenly about fifteen months ago. His work in this difficult and neglected branch of the foundations of mathematics must remain of fundamental importance for all future investigators.

As a teacher Hill had few equals: what impressed all who came in contact with him, apart from his clarity of exposition and extraordinary mastery of detail, was the moral atmosphere that radiated from him and left its mark on all those who approached him, even those who could not follow him into the realms of abstract thought. He gave, indeed, a splendid example of how a real man's work should be done, sparing no pains that the result, however slight, should be perfect; neglecting nothing, facing boldly all difficulties, a rare ideal of intellectual uprightness and moral courage.

This same ideal Hill carried into his everyday life and into the very arduous tasks which he undertook in connexion with the government of the University, a burden which he bore without a murmur, though his friends, well knowing that this meant, too often, the postponement or abandonment of research work of priceless value, sometimes deplored this as a tragedy.

Hill was a member of the Senate of the University from the date of its reconstitution in 1900 until 1926, when failing health compelled his retirement. For ten years he was chairman of the Academic Council, and for two years (1909–1911) vice-chancellor of the University. To his initiative were due many important developments, the full effects of which are only now beginning to be felt; in particular, the establishment of proper machinery for appointments to chairs and readerships and many improvements in the status and qualifications of teachers of the University.

Behind an outward appearance of almost diffident reserve Hill kept a heart full of sympathy and helpfulness and a fund of quiet and serene humour. Both his students and his colleagues looked to him when in trouble or difficulty, nor were they ever disappointed. It was characteristic of him that when, on his retirement, his friends asked him in what way he would wish them to commemorate his long connexion with the College, he remembered the financial struggle of his early years and asked that they should found a loan fund by means of which the difficulties of students in straitened circumstances might be temporarily relieved, while their spirit of independence was to be preserved by an undertaking of eventual repayment, so soon as they felt able to do so. There could, indeed, have been no more fitting memorial.

Prof. Hill married in 1892, Minnie Grace, daughter of Marriott Ogle Tarbotton, of Nottingham. Mrs. Hill died in 1920. He leaves two sons, both of whom earned distinction in the field in the flying service during the War, and one daughter.

PROF. J. M. COULTER.

By the death of Prof. John Merle Coulter on Dec. 23, after a few weeks' illness, American botany loses one of its most eminent exponents.

Prof. Coulter was born at Ningpo, China, on Nov. 20, 1851. After graduating at Hanover College, Indiana, he was appointed in 1872 botanist to the U.S. Geological Survey in the Rocky Mts., but returned to his old college as professor of natural sciences in 1874. He was then successively professor of biology, Wabash College (1879–91), president and professor of botany, Indiana University (1891–93), and president, Lake Forest University (1893–96). In 1896 he was appointed head of the new department of botany of the University of Chicago, to the development and work of which he devoted nearly thirty years, retiring in 1925. Since his retirement he has been adviser of the Boyce Thompson Institute of Plant Research, Yonkers, N.Y.

Coulter's earlier botanical work was floristic. The "Synopsis of the Flora of Colorado" (1874), a government publication, with Prof. Thomas C. Porter, incorporated the results of his own and earlier investigations in this part of the Rockies. A more extensive piece of work was his "Manual of the Botany of the Rocky Mountain Region from New Mexico to the British Boundary" (1885), a companion volume for the territory included to Gray's classic "Manual of the Botany of the Northern United States," for the sixth edition of which, in 1890 (with some extension of the area westwards), Coulter and Gray's successor, Sereno Watson, were jointly responsible. In association with the late Dr. J. N. Rose, Coulter published a revision of the North American Umbelliferæ (1888) and a Synopsis of the Mexican and Central American Umbelliferæ (1900).

Prof. Coulter is best known in the botanical world, however, for his connexion with the *Botanical Gazette* and his work in the department of botany of the University of Chicago. In November 1875, Coulter started the *Botanical Bulletin*, a modest little monthly of four pages, issued at a subscription price of one dollar a year, to afford a medium of publication for botanists of the western States comparable to those already existing in the eastern. It comprised short notes, mainly of local floristic interest, many of which were provided by the editor himself. With the second volume the name was altered to the *Botanical Gazette* to avoid confusion with the *Bulletin of the Torrey Botanical Club*, and the size was increased to eight pages. The venture prospered, other eminent botanists became associated with Coulter in the editorship, and when in 1896 the senior editor went to organise the new department at the University of Chicago and the *Gazette* became the property of the University, it was already recognised as a leading botanical journal. After more than fifty years of active editorship, Coulter in 1926 handed over the work to his former colleague, Prof. Henry Cowles, himself retaining the title emeritus editor.

With the development of the Chicago School of

Botany the *Gazette* also became a medium for the publication of its work. An important aspect of this work also found expression in the volumes on the morphology of the seed-plants, which are familiar to all students of botany. The original small volume on the seed-plants (1901) by Coulter and his assistant, C. J. Chamberlain, was expanded into the two important volumes dealing respectively with Angiosperms (1903) and Gymnosperms (1910) and represents a concise review of our knowledge of the detailed morphology, especially of the reproductive structures and the embryology in the two groups. The special value of these volumes depends on the fact that the subject matter had its origin or had been critically reviewed in the laboratory of the Chicago botany school.

In addition to his work as teacher and editor, Coulter played his part in the various associations and societies for the advancement of science in America. He had served as president of the Botanical Society of America, and of the American Association for the Advancement of Science. He was also a corresponding member of the British Association. In 1921 he was elected a foreign member of the Linnean Society of London. Botanists who attended the International Congress at Ithaca in 1926 will remember that Prof. and Mrs. Coulter took a prominent part in the reception of the delegates at the opening of the Congress in the Willard Straight Hall of Cornell University.

A. B. R.

DR. G. W. LEE.

GABRIEL WARTON LEE, who died in Edinburgh on Dec. 1, 1928, was the son of the late Dr. A. B. Lee of Geneva, the well-known author of "The Microtomist's Vade-Mecum," and of many valuable papers on cytological subjects. He was born in 1880, and received his education at Geneva, where, after a distinguished university career, he took the degree of D.Sc. In 1905 he joined the staff of Sir John Murray in Edinburgh, and carried out a number of important investigations on the deep-sea deposits brought back by the *Challenger* Expedition. The researches on glauconite which he undertook in collaboration with his cousin and colleague, Dr. L. W. Collet (now professor at Geneva), were published in the *Proceedings of the Royal Society of Edinburgh* in 1905–6.

In 1907, Dr. Lee was invited, on account of his special palæontological knowledge, to join the staff of the Geological Survey of Scotland; he was placed in charge of the Palæontological Department, and became responsible for the determination of the material annually collected from natural sections and from borings. Dr. Lee acquired an unrivalled knowledge of the Carboniferous fauna of Scotland and was a recognised authority on the Bryozoa, publishing in 1911 an important monograph on the British Carboniferous Trepostomata. He made valuable contributions to the Survey memoirs dealing with the Carboniferous rocks of the Edinburgh (1910) and Glasgow (1911 and 1925) districts, of East Lothian (1910), and of North Ayrshire (in the press). He assisted in the mapping of the complex geology of the Island of Mull, and had completed a detailed examination of the Mesozoic rocks of Scotland. His memoir on "The Mesozoic Rocks of Applecross, Raasay, and N.E. Skye" appeared in 1920, and his later work on these rocks was embodied chiefly in the following memoirs: "Pre-Tertiary Geology of Mull, Loch Aline, and Oban" (1925), "Geology of the Country around Golspie" (1925), and "Geology of Ardnamurchan" (to be published shortly).

In addition to his official work, Dr. Lee undertook the description of suites of fossils brought back from the Arctic by various expeditions. Among these may be mentioned the collections made by the late Dr. W. S. Bruce in Prince Charles Foreland in 1906–7 (*Proceedings, Royal Physical Society, Edinburgh*, 1908), and at Cape Cherney on the west coast of southern Novaya Zemlya in 1898 (*Transactions, Royal Society, Edinburgh*, 1909). Part of the material obtained by Prof. O. Holtedahl during the Norwegian expedition to Novaya Zemlya in 1921 was also submitted to him for determination and description (*Report of Scientific Results*, No. 22, Kristiania, 1904).

DR. E. VAN RIJCKEVORSEL.

DR. ELIE VAN RIJCKEVORSEL, who died on Oct. 18 last at the age of eighty-three years, was born at Rotterdam. After leaving the gymnasium there he went to the Polytechnic at Zurich and the University of Bonn, taking his doctor's degree in physics and mathematics at Utrecht in 1872. Soon afterwards he proposed to Prof. Buys Ballot a magnetic survey of the East Indian Archipelago at his own expense, only the instruments being provided by the Dutch Government. After a training at the observatories at Kew and Munich, he left for Java in December 1873, and largely extended Elliott's first survey of 1846–49, taking observations at more than a hundred stations. In spite of interruption by malarial fever, a similar survey was carried out in eastern Brasil between 1882 and 1885, with the assistance of E. Engelenburg.

After being nominated honorary assistant of the Dutch Meteorological Institute, Van Rijckevorsel made the first and only magnetic survey of Holland. In the meantime, many intercomparisons of standard instruments had been made, and magnetic observations in the Alps with Van Bemmelen followed; indeed, Van Rijckevorsel was one of the pioneers of international magnetic research, and was recognised as such by the honorary degree given him by the University of Glasgow in 1893, and by his nomination as one of the eight members of the first magnetic commission created by the International Meteorological Committee in 1896 at Paris.

Since 1896, Van Rijckevorsel has developed another side of his scientific interests. At the British Association at Toronto a paper was presented, "On the Temperature of Europe," followed by a series of papers in German, partly published by the Institute at De Bilt, which trace

constant, possibly cosmic, influences causing secondary maxima and minima in the yearly range of meteorological elements and terrestrial magnetism and lead to the calculation of numerous periods, even in mortality and nativity. Part of the material was provided by the author, copying unpublished observations abroad during repeated sojourns in milder climates during winter time.

Van Rijckevorsel was a lonely man for a great part of his life, and always busy—his love of Nature, his skill in drawing, and his taste in forming ethnological collections will be long remembered by his friends and countrymen. Time will judge of the importance of his life-work, but his earnest devotion to international science ensured him the esteem of colleagues from many nations.

E. VAN E.

MR. C. L. TEMPLE, C.M.G.

WE regret to record the death of Mr. Charles Lindsey Temple, C.M.G., formerly Lieutenant-Governor of Northern Nigeria, which took place on Jan. 9 at Granada, Spain. Mr. Temple was a son of the Right Hon. Sir Richard Temple, formerly Governor of Bombay, and a notable figure in the political world of the late nineteenth century, and a brother of the present Sir Richard Temple, the distinguished authority on Indian culture and literature.

Charles Temple was born in 1871, and entered the Consular Service in Brazil in 1898. Through the influence of Sir Frederick Lugard, he joined the Nigerian Service in 1901, where he rapidly showed himself an administrator of sympathetic understanding in dealing with native affairs. Papers on the natives of Northern Nigeria, contributed by him to the *Journal of the Royal Geographical Society* in 1912, and by his wife to the meeting of the British Association in 1913, showed how thoroughly the essential factors of the situation had been grasped. Temple was a staunch upholder of the theory of government that it was the duty of the white races to accept, so far as possible, tribal laws and customs as a guide in shaping the development of backward peoples. He regarded it as essential that natives should be associated with whites as much as possible in the government of their own country. The views and the principles upon which he carried out his administrative duties were embodied in a book, "Native Races and their Rulers," which appeared in 1918 and has since become a text-book for administrators, and a powerful influence in the government of Nigeria.

Mr. Temple was Chief Secretary of Northern Nigeria from 1910 until 1913, and was appointed Lieutenant-Governor of the Protectorate in 1914, holding that office until 1917, when his health broke down. He married Miss Olive MacLeod, daughter of Sir Reginald MacLeod of MacLeod, herself well known as a traveller and the author of a number of studies of the peoples of Nigeria, based on material mostly collected during her husband's term of office.

PROF. A. W. BICKERTON.

PROF. A. W. BICKERTON, whose death on Jan. 23, at the advanced age of eighty-seven years, is announced, was a well-known figure in astronomical and other scientific circles. He was born at Alton, Hants, on Jan. 7, 1842, and educated at the Grammar School there and the Royal School of Mines, South Kensington, of which he became an Associate. After leaving the College he was appointed organiser of science classes at the Hartley Institute (now University College), Southampton, and in 1874 went to Canterbury College, Christchurch, New Zealand, as professor of chemistry and physics. While there he had among his students Sir Ernest Rutherford, who in the *Times* of Jan. 25, pays an appreciative tribute to the stimulating lectures given by his old teacher, and remarks: "His powers of popular exposition, his enthusiasm and versatility were of great value in promoting an interest in science in a young community."

About twenty years ago Prof. Bickerton came to England with the express purpose of developing and making known an impact theory of cosmic evolution conceived by him in 1877, and of which he regarded the appearance of new or temporary stars as examples. His view—described in a number of papers published by the New Zealand Institute and other societies—was that stars were formed by the grazing collision, or partial impact, of two cosmical masses. The new lucid object thus brought into existence was not regarded as made up of the combined masses of the colliding clouds, but as a third body formed by the material detached from the colliding masses. A suggestion of this kind could obviously scarcely be placed in the category of fundamental astronomical theories without substantial observational or dynamic evidence, neither of which Prof. Bickerton was able to provide. He was discouraged by the indifference shown by astronomers generally to his views, yet he never lost his enthusiasm, and believed that he had found the truth and that it would be established in due season by both mathematical physics and astrophysics. He would, we believe, be content with the epitaph, "Magna est veritas, et praevalet."

WE regret to announce the following deaths:

Dr. T. O. Bosworth, author of "Geology of the Tertiary and Quaternary Periods in the North-West Part of Peru," on Jan. 18, aged forty-six years.

Dr. John K. Haywood, chemist in charge of insecticide supervision, food, drug, and insecticide administration in the U.S. Department of Agriculture, on Nov. 30, aged fifty-four years.

Dr. Fernand Widal, professor of internal pathology in the University of Paris, whose name is associated with the agglutination test for the diagnosis of typhoid fever, on Jan. 14, aged sixty-six years.

Prof. R. H. Yapp, Mason professor of botany in the University of Birmingham since 1919, on Jan. 23, aged fifty-seven years.

News and Views.

WE referred last week, p. 138, to the meeting of the Royal Society on Jan. 17, at which Prof. Eddington described some speculations on a new development of quantum mechanics, published in the January issue of the *Proceedings* of the Society. So much prominence has been given to the paper in the public press that some further remarks upon it in these columns may be worth while. The speculations put forward are of a very interesting type, for they attempt to assimilate what we now call interchange of electrons to a transformation in a new co-ordinate or co-ordinates, similar to a Lorentz transformation in space-time co-ordinates in that it can never be observed. The starting point of these speculations is the observation that we now describe the interaction of electrons by two principles, Coulomb's electrostatic forces and Pauli's exclusion principle, and that every principle of scientific æsthetics requires us somehow to weld them into one. This observation is perhaps the most promising and interesting part of the paper. The main part of the paper is concerned with speculations as to how perhaps this might be done, and the description of the interchange of electrons already alluded to is Prof. Eddington's attempt at a weld.

PROF. EDDINGTON's whole speculation is extremely tentative, even for a new step in quantum mechanics, and very properly so propounded. If his main idea is correct, that the principles of Coulomb and of Pauli are two aspects of the same feature of our world, there must necessarily be a theoretical connexion between the two constants, ϵ^2 and $hc/2\pi$, which they respectively introduce. Prof. Eddington's tentative speculations suggest a value of 136 for this ratio; *all* the existing experimental evidence, provided that our main theoretical formulæ are trustworthy, are in favour of a value very near to 137, a value which of course is not necessarily integral. It is quite possible that Prof. Eddington's theoretical result of 136 may be right, even if every word which he or any one else can as yet say about his theory is a totally wrong interpretation of it, like so much else which we still say of the easier aspects of quantum mechanics. It is far too soon to be confident either way. But if the ratio is really 136, it is already clear that the new theory when complete must involve small but far-reaching changes in the relations between the primary physical constants and, for example, Rydberg's constant. It will be a matter of the highest interest if it ultimately turns out that the formula for Rydberg's constant, the corner-stone of modern physical theory, was slightly wrong after all! At present it is proper to confess that we do not in any sense understand the new theory, still less know if it is right. Its further study will no doubt be prosecuted with interest and vigour.

IN order to introduce into the Leningrad Academy of Sciences, which three years ago celebrated its 200 years of independent scientific life, it was decided last year to enlarge the Academy by adding to it forty new members. A list of candidates has been approved by the authorities, and amongst the new academicians several active supporters of the government have been duly elected. Three of the candidates put forward by communistic organisations failed, however, according to the *Times* of Jan. 28, to obtain the two-thirds majority of votes necessary to secure election, probably because of their insufficient qualifications. The Soviet authorities insist now that the Academy must waive its statutory regulations and take a fresh ballot on the three rejected candidates. A meeting of the Academy summoned to consider this extraordinary proposal decided that, although it was contrary to the statutes, it has to be accepted. Nine academicians, however, voted against acceptance, and their names have been published by the Soviet press as follows: Pavlov (physiologist), Levinson-Lessing (geologist), Borodin (botanist), Liapunov (mathematician), Karsky (ethnologist), Lavrov, Petrushevsky, Vladimirtseff, and Sakulin; every one of these nine names is well known—indeed, some are famous amongst the leading men of science of the whole world. Various startling projects of reconstructing the Academy so as to make it support actively the government policy are discussed by the official Soviet press, but apparently no definite decision has been arrived at so far.

THE neon tubes which are now so familiar to the public in various script sign advertisements have found a useful application in replacing white lights for lighthouses serving air routes. In a new light at Lympne, sixteen tubes twenty feet long are employed in the form of a vertical truncated cone. The light is said to have a candle power of 6000 and to be visible in clear weather for 45 miles. The neon spectrum gives a number of lines lying for the most part towards the red end of the spectrum, the yellow line 5853 A. being specially prominent. Thus the normal colour of the tube is red orange, unless much argon or mercury vapour are also present. It is therefore possible to obtain a radiation which is comparatively little subject to atmospheric scattering (the intensity of scattering is inversely proportional to the fourth power of the wave-length) while yet remaining of high visibility. The characteristic colour of the light is a strong recommendation; it would be made somewhat more red owing to scattering when seen through fog, but the change would be small in comparison with that experienced in connexion with any white light. Experiments have shown that even when the neon light failed completely to penetrate a layer of fog it made a "large red luminous patch on the top of the fog." Such a light has now been installed at the Lympne aerodrome on the London-Paris air route.

FOR some time it has been rumoured that Prof. Einstein has been about to publish the results of a protracted investigation into the possibility of generalising the theory of relativity so as to include the phenomena of electromagnetism. It is now announced

that he has submitted to the Prussian Academy of Sciences a short paper in which the laws of gravitation and of electromagnetism are expressed in a single statement. The *Daily Chronicle* of Jan. 26 reports an interview with Prof. Einstein in which he explains in outline the scope of his new achievement. "For years," he is reported to have said, "it has been my greatest ambition to resolve the duality of natural laws into unity. This duality lies in the fact that physicists have hitherto been compelled to postulate two sets of laws—those which control gravitation and those which control the phenomena of electricity and of magnetism. . . . Many physicists have suspected that two sets of laws must be based upon one general law, but neither experiment nor theory has, until now, succeeded in formulating this law. I believe now that I have found a proper form. I have thought out a special construction which is differentiated from that of my relativity theory, and from other theories of four-dimensional space, through certain conditions. These conditions bring under the same mathematical equations the laws which govern the electromagnetic field and those which govern the field of gravitation. The relativity theory reduced to one formula all laws which govern space, time, and gravitation, and thus it corresponded to the demand for simplification of our physical concepts. The purpose of my work is to further this simplification, and particularly to reduce to one formula the explanation of the field of gravity and of the field of electromagnetism. For this reason I call it a contribution to 'a unified field theory.' . . . Now, but only now, we know that the force which moves electrons in their ellipses about the nuclei of atoms is the same force which moves our earth in its annual course about the sun, and is the same force which brings to us the rays of light and heat which make life possible upon this planet."

PROF. EINSTEIN gives no indication of the line of thought he has followed or of the precise character of the new law. His paper, it is stated, will be published in a few days. As an illustration of the remark that many physicists have suspected the existence of a general field law, we may quote the following passage from Prof. Eddington's recent book, "The Nature of the Physical World." After an account of the relativity interpretation of non-empty space, he writes, "It should be added, however, that this is a summary description and not a full account of the non-emptiness, because we have other exploring apparatus—magnets, electroscopes, etc.—which provide further details. It is usually considered that when we use these we are exploring not space, but a field in space. The distinction thus created is a rather artificial one which is unlikely to be accepted permanently. It would seem that the results of exploring the world with a measuring scale and a magnetic compass respectively ought to be welded together into a unified description, just as we have welded together results of exploration with a scale and a clock." Apparently Einstein's new work has accomplished such a welding, but details cannot be gathered until the paper becomes available.

OF all British men of science, none commands our admiration and respect more than Michael Faraday, who by the simplicity and nobility of his character endeared himself to all those around him and by the variety and importance of his discoveries made possible many of the extraordinary advances of modern science. His life's work was done in the laboratory of the Royal Institution, and it was there, on Aug. 29, 1831, he made his first successful experiment on electromagnetic induction; an experiment which, following in the wake of those of Oersted, Arago, Sturgeon, and Ampère, marks the first of a series of discoveries to which we owe our command of electricity to-day. Recognising the epoch-making character of that experiment, the Royal Institution proposes to take steps to celebrate its centenary, and accordingly has issued an invitation to those interested to be present at a meeting of the Royal Institution on Feb. 5 at 4.30 P.M., when the proposal will be considered. In the invitation the Royal Institution points out that the centenary of the British Association also falls in 1931, and that certain important conferences on electricity will be held in London that year, and in directing attention to this matter says: "It seems probable also that the event may provide a unique and most favourable opportunity for a review of the great contributions which British workers have made to the scientific and industrial advances of the past century. It is certain that such a review might be made a source of inspiration and encouragement to the nation." At a dinner of the American Institute of Electrical Engineers in 1901, the toasts were: "The Land of Ampère," "The Country of Faraday," "The Successors of Ohm," "The Heirs of Volta," and "The Legatees of Franklin." That was a happy demonstration of the freemasonry of science, and it would be a fortunate thing if the efforts of the Royal Institution lead to an international gathering to commemorate the work of one of whom Tyndall said that "he prized the honour of being Faraday's successor less than the happiness of having been his friend."

THE centenaries of scientific interest which occur in 1929 will recall some of the most remarkable men in the history of scientific discovery; men of various nationalities; pioneers in many branches of science, and men differing greatly in character. England, Germany, Holland, France, the United States, and Norway, will all have their celebrations, some of which will no doubt attract world-wide attention. Perhaps the most notable name to be recalled is that of Huygens, who was born at The Hague on April 14, 1629, and died there on June 8, 1695. As a connecting link of the age of Galileo and that of Newton, Huygens is one of the leading figures in seventeenth-century science. Among Englishmen we note the approaching centenary of the death of Davy, who passed away on May 29, 1829, and that of Young, who died on May 10. We have already referred to these famous men in these columns, and it is to be hoped the commemorations will be worthy of the occasions. No less a notable figure is that of Lamarck, who died on Dec. 18, 1829, and whose statue stands at the entrance to the Jardin des Plantes, for which he did so much. On April 6

occurs the centenary of the death of the brilliant but short-lived Norwegian mathematician Niels Heinrik Abel, while later in the year come the centenaries of the births of the German chemists Kekulé and Griess, of the French chemist Schützenberger, the Austrian geologist Hochstetter, the American geologist Hayden ; while another notable American man of science born in 1829 was Asaph Hall, the discoverer of the satellites of Mars. The United States and England alike will no doubt in some way pay tribute to the memory of James Smithson, through whose bequest arose the great Smithsonian Institution at Washington. Smithson died at Genoa in June 1829.

BESIDES these anniversaries we may direct attention to the bi-centenary of Thomas Newcomen, who may properly be called the father of power engineering. The steam- or fire-engine had been the subject of experiments by Papin, Worcester, Savery, and others, but the introduction of the atmospheric beam engine for pumping purposes was mainly the work of Newcomen, the Dartmouth blacksmith. Newcomen's engines provided the first solution of the problem of pumping from deep mines, and the form he introduced continued to be constructed right throughout the eighteenth century, and one or two examples were at work within quite recent times. Moreover, it was the model of a Newcomen engine, still preserved in the University of Glasgow, which led Watt to his epoch-making inventions. But Newcomen engines were in use forty years before Watt began his experiments, and when at the Watt centenary of 1919 a small group of engineers founded a society for furthering the study of the history of engineering and technology, they most appropriately called it the Newcomen Society. Though not a large body, the Newcomen Society has by its activities and its excellent *Transactions* admirably fulfilled its purpose, and this coming summer it is holding a joint meeting with the Devonshire Association in order to pay due homage to the memory of Newcomen. Born at Dartmouth in 1663, Newcomen died in London on Aug. 5, 1729, and lies in an unknown vault in Bunhill Fields Burial Ground. Another centenary of interest to engineers is that of the famous locomotive trials at Rainhill in October 1829, when the great competition took place between Hackworth's *Sans Pareil*, Ericsson's *Novelty*, and Stephenson's *Rocket*, the latter the best-known locomotive in the world. To this event the Newcomen Society also rightly proposes to direct attention.

THE second report of the National Fuel and Power Committee to the President of the Board of Trade (Cmd. 3252, London: H.M. Stationery Office, 9*d*. net) recommends that legislation be promoted without delay to provide alternative procedure under section 10 of the Gas Regulation Act, whereby the Board of Trade, by Departmental Order, may grant to gas undertakings, power to raise additional capital and borrow money on mortgage to the extent of the undertakers' paid-up share capital ; power to offer new capital for subscription to existing holders, consumers, and employees ; power to effect joint working arrangements with other undertakings, and to institute a two-part tariff system of charge for gas. The therm system of charge is considered a fair one, and the Report recommends that, from an appointed day, existing statutory gas undertakers, except very small ones, supplying less than, say, 20 million cub. ft. of gas per annum, should be required to supply gas on a thermal basis and become subject to the purity, pressure, and testing requirements of the Gas Regulation Act. All gas undertakers should fulfil the requirements of the Act as regards purity and pressure of gas, it being understood that, in the case of a non-statutory undertaking, no penalty would be incurred when a deficiency in respect of these requirements was due to circumstances not within its control. The growing practice of supplying artificially dried towns' gas necessitates the amendment of the section of the Act defining the calorific value in terms of unit volume of gas saturated with water vapour. No quarterly average value of calorific value should be assessed unless at least six tests of the gas have been made during the quarter. At present, gas undertakers are customarily permitted to work up residuals purchased from other undertakers or elsewhere to the extent of only one-third of the like residuals obtained from their own manufacture of gas. It is recommended that this restriction as to quantity, where it exists, be removed.

ACCORDING to a recent announcement by Prof. James H. Breasted, the organisation on an extended scale of the Institute of Oriental Research of the University of Chicago is now made possible by an endowment of 9,500,000 dollars, of which the greater part is already assured. Among the objects to which this sum is to be devoted are the provision of a new building on the campus of the University, an annual grant towards carrying out projected researches over a period of the next ten years, and an endowment for teaching which will enable the Institute to avail itself of the services of the leading Orientalists and historians of the world. The plan of work, now in process of being framed, will include a series of expeditions sent out from the central organisation, which will work side by side and in close co-operation along the whole of what is termed the 'archæological front' of the Near East, including Babylonia and Assyria as well as Persia and its neighbours.

THE marvels of Ur multiply. Within ten days of his first report of the season, Mr. Woolley has further sensational discoveries to record. His account of the opening up of another pit shaft, in the *Times* of Jan. 22, leaves the reader in amazement no less at the light they throw on Sumerian burial practices than at the surprising wealth of objects of Sumerian art and their character. Now we learn of the sacrifice of a groom and of asses found with traces of a chariot and the remains of the ornament of the harness, on a sacrificial floor composed of a mat roof covering another sacrificial chamber with its array of victims. This in turn leads to a death pit with forty-five victims, of whom no less than thirty-nine are women, and six are indeterminate. Of headdresses of gold and precious stones similar to those of the nine court ladies found last year, thirty-four have been found, and the other contents of the pit, so far as cleared, are no less remarkable in quantity and character

both of workmanship and conception. Two statues are unique—rampant rams with heads and legs of gold, horns and shoulder hair of lapiz, the fleece of white shell, each tuft carved separately, and the belly of silver.

CAPT. PUREFOY, on behalf of the Committee for the Protection of British Butterflies, appointed by the Entomological Society of London, has presented to the Department of Entomology of the British Museum (Natural History) a set of specimens of the first brood of the imported Dutch form of the large copper butterfly, reared in Wood Walton Fen, near Huntingdon. The British form of this butterfly, formerly moderately common in the fen country, where its caterpillar fed upon the giant water-dock, has been extinct since 1848. About ten years ago a form was discovered in Holland, whence was derived the stock with which it is hoped to repopulate some part at least of the area formerly occupied by the insect. The specimens presented to the Museum are intended to form the commencement of an annual record of the broods, so that any variational tendencies in the colony may be more easily recognised. Capt. Purefoy has also presented a set of specimens from the Irish colony established by him a number of years ago, which has been well maintained ever since. From Dr. J. Schwetz the Department has also received specimens of a new species of tsetse-fly, taken by him in the region of the Lower Lomami River, Belgian Congo. Since the new specimen belongs to the same group as *Glossina palpalis*, the tsetse chiefly responsible for the spread of human sleeping sickness, its discovery may be of medical importance. The skeleton of the large *Ichthyosaurus* extracted at the end of November last from the Lower Lias in the quarry of the Red Triangle Cement Works at Harbury, Warwickshire, has been presented by the Portland Cement Selling and Distributing Co. to the Department of Geology of the Museum. The skeleton is deeply imbedded in nodules of limestone.

PROF. A. C. SEWARD'S Friday evening discourse, delivered on Jan. 25 at the Royal Institution, was entitled "Greenland: As it is and as it was." He gave a brief description of the geological structure of the country, the present inhabitants, the ice-sheet and icebergs, and of the Arctic flora. The only representatives of trees are stunted willows and the prostrate dwarf birch. Many of the flowering plants have a circumpolar distribution; some of them being also members of the alpine flora of Scotland and Switzerland, while others are unknown in Europe and occur in North America. The present conditions in Greenland are much more favourable than in corresponding regions in the far south on the borders of the Antarctic continent. Prof. Seward then discussed the value of fossil plants as evidence of climatic conditions of the past. In rocks of Cretaceous age on Disko Island and at localities on the mainland about halfway up the western coast of Greenland there are fossil ferns closely related to species of *Gleichenia*, now widely spread in the southern tropics, and other ferns related to a species now confined to Malaya; there are conifers now unknown in Europe, and abundance of trees with leaves scarcely distinguishable from those of the maidenhair tree (*Ginkgo biloba*). Special attention was directed to the presence, in the Cretaceous flora, of plane trees, of trees closely related to existing Magnolias and trees akin to the tropical bread-fruit tree, and representatives of other families now characteristic of subtropical or tropical regions.

THE paper dealing with "Colour and its Applications," read by Dr. L. C. Martin before the Illuminating Engineering Society on Jan. 22, contained an interesting survey of colour measurement, in the course of which an ingenious new colorimeter developed at the Imperial College of Science by Mr. W. D. Wright was described. The lecture was aided by some effective demonstrations, by Mr. C. F. Smith, of colour-mixtures and harmonies, for which his 'mutochrome' apparatus proved well adapted. Dr. Martin also discussed the relation between colour and acuteness of vision, and presented a series of curves illustrating the relation between colour and visual speed. Much of the discussion was concerned with 'artificial daylight,' and the need for a practical standard of white light was emphasised. The arbitrary standard, based on the use of an electric incandescent lamp, run at a prescribed pressure and equipped with a standard blue filter, is stated to furnish radiation equivalent to that of a black body maintained at about 2900° K., and has evidently possibilities. It was interesting to learn that a standard specification for artificial daylight is now likely to prove a practical project.

THE current issue of the *Journal of the Marine Biological Association* contains a description of the Laboratory at Plymouth and a list of publications recording the results of researches carried out there or under the auspices of the Association on the North Sea coast from 1886 to 1927. This bibliography of nearly a thousand papers, ranging over morphology, biology, and various branches of economic marine zoology—on fishes, oysters, cockles and scallops, the shipworm, crabs, lobsters, and sponges—serves to emphasise the close correlation between pure and applied science, and shows that the wise policy of the founders of the Association—to aid science and industry — has been consistently followed. The Laboratory provides facilities for all kinds of biological, work and appreciative reference should be made also to the successful courses for advanced students, held during the Easter and summer vacations. The major parts of the organisation of the Plymouth Laboratory has been built up during the thirty-three years' directorship of Dr. E. J. Allen, to whom and to his staff are due congratulations, not only for their many contributions to the advancement of our knowledge of the sea, but also for the fine spirit of helpfulness which prevails in the Laboratory.

THE gradual disappearance of the European bison, which reached its most serious stage during the War, has been watched with much concern, and an association was formed a few years ago with the object of endeavouring to prolong the existence of this interesting species. This good cause has received a severe

blow in the news brought back by Prof. J. Pujanov, of Semferopol, who has just completed a survey of the Caucasus reserve. In 1911 the herd in the Caucasus region numbered 1000, and in 1924, when 25 animals were still known to be alive, the Soviet Government set aside an area of 1100 square miles as a permanent bison reserve. Last year a group of zoologists who had had special experience explored this region thoroughly, searching every valley. Not a single living bison was seen. Bones in plenty were discovered of animals apparently only a year or two dead, and some bore bullet-marks. The bison seem to have been shot by poachers, the patrol of the reserve having been insufficient to stop illegal shooting. It is stated that one or two animals may still possibly lurk in remote fastnesses in the area, but for all practical purposes the Caucasus herd may be regarded as extinct.

AN able summary, over the initials 'I.D.S.,' appears in the October issue of *Psyche*, against the suggestion of some psychiatrists that those patients whose mental disorder is difficult to specify, or does not constitute them a danger to themselves or others, should be detainable by some informal compulsion warranted by their relatives and by medical opinions. The advantages claimed are, that the earlier treatment thus enforced would be more effective than if delayed until the patient should be certified, and that the informal nature of the proceedings would avoid the stigma of insanity. The writer claims in opposition that only a small proportion of mild cases ever reach the asylum, that institutional life does not have a good effect on the individual, that the district asylums have not the staff for the necessary treatment, and the average medical officer is ill-instructed in psychiatry and mental treatment. He also quotes with approval Dr. Millais Culpin's views expressed in a letter to the *Times* last autumn as to the probability of the stigma very quickly being affixed to this compulsory detention. He suggests that the provision of outdoor treatment is the better course to follow, and points out that if there is any treatment worth having, people will gladly avail themselves of it.

WITH the financial help of the firm of Zeiss of Jena, the *Zeitschrift für Instrumentenkunde* has been able to carry out its project of issuing occasional supplements dealing with the history of the progress of optics. The first part appeared in December under the title *Forchungen zur Geschichte der Optik*. It consists of 40 pages of the same size as those of the *Zeitschrift*. Five pages are occupied by an article by Dr. M. v. Rohr, the editor, devoted to an extract from Sir J. F. Herschel's Journal, giving an account of his visit to Fraunhofer at Munich in September 1824, and to other evidence of the rapid spreading of a knowledge of Fraunhofer's work amongst English physicists in the next few years. The remainder of the issue is devoted to an article by Dr. H. Boegehold giving the history of the achromatism of prisms and lenses from the discovery of the effect for glass and water by Newton in 1704, its use by Dollond in 1757, and its general recognition as an optical method by about 1775.

PROF. EJNAR HERTZSPRUNG, of Leyden Observatory, has been appointed George Darwin lecturer of the Royal Astronomical Society for 1929. The lecture will be delivered at the May meeting of the Society.

AN earthquake of moderate intensity was recorded at Kew Observatory at 20 hr. 48 min. 50 secs. G.M.T. on Jan. 24. The epicentre is estimated to have been 5580 miles away, probably in Central America.

SIR ERNEST RUTHERFORD will open a discussion at the Royal Society on Feb. 7 on "The Structure of Atomic Nuclei." Dr. F. W. Aston, Dr. J. Chadwick, Dr. C. D. Ellis, R. H. Fowler, and Prof. O. W. Richardson will take part in the discussion.

THE Pharmaceutical Society of Great Britain will hold a conversazione at the Society's house at 17 Bloomsbury Square, London, W.C.1, on Tuesday, Feb. 12, when the museums, school, and research and pharmacological laboratories will be open to inspection.

THE Progress Medal of the Royal Photographic Society of Great Britain has been awarded by the Council to Mr. Olaf Bloch, in recognition of his various inventions, researches, and publications, which have resulted in important advances in the development of photography.

THE Council of the Institution of Naval Architects has awarded a premium for the year 1928 to Lieut.-Colonel V. C. Richmond for his paper on "Some Modern Developments in Rigid Airship Construction," and a joint premium to Mr. E. Leslie Champness and Mr. Frank McAlister for their paper, "Further Notes on the Relative Strength of Fine and Full Cargo Vessels." The premiums will be presented on Mar. 20 at the opening of the annual general meetings, which will be held at the Royal Society of Arts, John Street, W.C.2.

THE Institute of Physics announces additional privileges for student members. Registered student members pay a fee of five shillings per annum, which is credited against the entrance fee on election to corporate membership. In future, in addition to existing privileges, students will receive the published lectures given before the Institute free of charge, and will be allowed to subscribe to the *Journal of Scientific Instruments* at the privileged rate of ten shillings and sixpence per annum.

THE Council of the Institution of Electrical Engineers has made the eighth award of the Faraday Medal to Signor Guido Semenza, of Milan. This medal is awarded by the Council of the Institution not more frequently than once a year either for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science, without restriction as regards nationality, country of residence, or membership of the Institution. Signor Semenza has for many years taken a leading part in the development of the applications of electricity.

THE non-magnetic yacht *Carnegie* has reported her arrival at Callao, Peru, on Jan. 14. Because of a storm and loss of an anchor at Easter Island, the vessel left there on Dec. 12, two days before the time originally set. Unfavourable winds drove her south from her course as planned to 40° south latitude in

longitude about 95° west. Captain Ault reports continued excellent observational results for the full programme since leaving Easter Island. Twenty-three bottom samples were obtained on the trip from Balboa to Easter Island to Callao ; those from Easter Island to longitude 95° west were red clay with volcanic mud. It is expected that the *Carnegie* will sail on Feb. 3 from Callao for Papeete, Tahiti.

THE claim by Leone Caetani, author of the "Annali del' Islam," that the great Moslem migration into North Africa was due to the increasing desiccation of Arabia at that period, has been discussed by Prof. Alois Musil in an Appendix, No. 10, to his work on Northern Negd in the fifth volume of his "Explorations in Arabia," in process of publication by the American Geographical Society. Prof. Musil insists that this claim is quite invalid, and that there is no evidence of any material climatic change in Arabia during historic times. Prof. Musil's detailed discussion of this question is useful, as the view that the Arab emigration was due to increasing desiccation has been adopted recently by Sir Thomas Arnold (1924), and by Prof. MacMillan Brown, "Problems of the Pacific," 1927.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A junior assistant (engineer) at the Fuel Research Station, East Greenwich—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (Feb. 14). An assistant for work on virus diseases of the potato, and an assistant for field work in connexion with the development of potato culture, each under the Department of Agriculture for Scotland—The Establishment Officer, Department of Agriculture for Scotland, Queen Street, Edinburgh (Feb. 16). A reader in mathematics at Birkbeck College—The Academic Registrar, University of London, South Kensington, S.W.7 (Feb. 18). A lecturer in agriculture in the University of Leeds—The Registrar, The University, Leeds (Feb. 18). A professor of electrical engineering at the College of Engineering, Guindy, Madras—The Secretary to the High Commissioner for India, General Department, 42 Grosvenor Gardens, S.W.1 (Feb. 23). An evening lecturer in magnetism and electricity at the Wimbledon Technical Institute—The Principal, Technical Institute, Wimbledon, S.W.19. A Secretary to the Technical Institute, Wandsworth—The Principal, Technical Institute, Wandsworth, S.W.18.

Our Astronomical Column.

COMET SCHWASSMANN-WACHMANN (2).—The new comet 1929*a* proves to be one of short period, like the first one discovered by the same observers. Images of the comet were found on plates taken on Jan. 4 and 12 (the latter at Uccle Observatory). From these positions, combined with photographic observations on Jan. 20, Prof. G. van Biesbroeck and Mr. Y. C. Chang have computed the following orbit (*I.A.U. Circ.*, No. 218) :

$$\begin{array}{rl} T & \text{1929 April 1 36 U.T.} \\ \omega & 2^\circ\ 15' \\ \Omega & 126\ \ 36 \\ i & 3\ \ 39 \end{array} \Bigg\} 1929{\cdot}0$$

$$\begin{array}{rl} \log q & 0{\cdot}3075 \\ \text{Period} & 6{\cdot}825 \text{ years.} \end{array}$$

EPHEMERIS FOR 0^h.

	R.A.	N. Decl.	log r.	log Δ.
Jan. 28.	$5^h\ 38^m\ 16^s$	20° 59′	0·3201	0·0988
Feb. 5.	5 39 1	21 23	0·3174	0·1161
13.	5 41 57	21 47	0·3149	0·1348
21.	5 47 25	22 10	0·3126	0·1546

The distance from the sun is diminishing, but that from the earth increasing ; the brightness should not diminish rapidly. The comet should be observable until May at least. If these elements are accurate, there was a near approach to Jupiter (about one-third of a unit) in November 1926.

FORBES'S COMET.—The following are the latest observations to hand of Forbes's Comet :

U.T.	R.A. 1928·0.	S. Decl. 1928·0.	Observer.
Dec. 8·47988	$12^h\ 54^m\ 21{\cdot}15^s$	31° 55′ 9·4″	G. van Biesbroeck, Yerkes
9·48678	12 56 50·03	32 22 2·7	„ „
10·48032	12 59 15·77	32 47 48·7	„ „
8·06210	12 53 19·23	31 43 36·1	H. E. Wood, Johannesburg.

Astr. Nach., 5608, reports an observation of this comet : Oct. 27·81 U.T., R.A. $11^h\ 1^m\ 24^s$, N. Decl. 8° 32·2′. There is little doubt that the comet was seen, but the position given is very rough.

A POSSIBLE COMPANION TO SIRIUS B.—A letter from Dr. R. T. A. Innes in the *Observatory* for January states that a faint star has been suspected near Sirius B on several nights ranging from Feb. 4, 1926, to Mar. 20, 1928. Its distance from B varies from 1″ to 2″ and the period is estimated to be from 18 months to two years. It is estimated as of magnitude 12. On some evenings several observers saw it. Various eyepieces were tried, and every precaution was taken to guard against illusion, but the object is so difficult that its existence is not absolutely guaranteed. Dr. van den Bos recalls that Prof. Fox suspected the duplicity of B with the 18½-inch Clark refractor. He gave P.A. 231°, distance 0·8″, date 1920·110.

Dr. van den Bos also gives some measures of the companion of Procyon, though this was so difficult that he does not guarantee its objective existence :

	P.A.	Dist.
Feb. 8, 1927 . . .	198·6°	3·06″
Oct. 27, 1928 . . .	230·7	2·07

He had purposely consulted no ephemeris on either occasion, but afterwards found that the first position was in fair accord with Dr. Spencer Jones's ephemeris.

It may be worth while to point out that the distance and period as estimated by Dr. Innes are not compatible with each other. From the meridian observations of the bright star, the mass of Sirius B has been deduced as 0·96 of the sun's mass. If Sirius B is double, this would be the joint mass of its two components. The parallax 0·38″ is very well determined. Taking the mass as equal to that of the sun, a semi-major axis of 1·52″ would give a period of 8 years. One of 1·00″, the smallest value suggested by Dr. Innes, would give a period of 4·27 years. Thus, either the distances given by him are considerably overestimated or the period is underestimated. The distance given by Prof. Fox, 0·8″, would give a period of 3 years, if assumed to be the unforeshortened length of the semi-major axis. The distances were estimated, not measured, at Johannesburg, the suspected star being too faint to set a wire upon.

Research Items.

The Spearthrower in America.—Some remarkable spearthrowers of ancient American origin are described by J. Alden Mason in the *Museum Journal* (Philadelphia) for September 1928. At the present day the spearthrower is used in America only by the Eskimo, certain of the tribes of the Amazon, and the Tarascan Indians of Lake Patzcuaro, Mexico; but formerly it was employed much more widely. Specimens are known from the pre-Cliff Dweller remains of Utah belonging to the people known as the Basket-makers, from pre-Columbian Florida, and from pre-Columbian graves of the coasts of Peru and of Ecuador and Colombia, from the Aztecs of the time of Montezuma and from the Toltecs. The Haitians of the time of Columbus used it, as did certain Californian tribes of a century and a half ago. Not more than about thirty examples have been found in any one of these areas. Of the specimens here described, one belongs to the so-called Thule culture of the early Eskimo, and was found by W. B. Van Valin in the region of Point Barrow in 1919 in a series of mounds. It differs from any of the modern types, being of a superior grade alike from the æsthetic, technological, and utilitarian points of view. It is of a coniferous wood and measures 14½ in. in length by 2⅝ in. maximum width. Its peg is of ivory. The second example belongs to the Basket-makers' culture of Utah and was the first to be found in the south-west. It is remarkable for a number of ceremonial objects attached to the handle. These include the tooth of a canine or feline, wrappings of yucca fibre, cotton yarn, and fur; and an X-ray examination has revealed four beads, probably of turquoise and representing the heart of a fetish bird, which lie under the yarn and cannot be otherwise examined owing to the fragility of the material. Two spearthrowers which are unique, and the rarest known in America, come from Marco Key, Florida, where they were discovered in 1896. They are longer and more slender than spearthrowers from other regions, the closest approximations being those in use among certain eastern Colombian tribes. A carved rabbit at the distal end of one is reminiscent of the carved spearthrowers of the Magdalenian period of palæolithic Europe.

Rescue and Reclamation of Fish.—The Division of Fish and Game of the Californian Department of Natural Resources has developed a strange industry —the rescue and reclamation of lost, or potentially lost, fishes. Black bass and other spiny-rayed fishes take advantage of flood conditions to spawn in areas which at the time seem perfectly suitable, but as soon as the overflows begin to dry through evaporation, both the newly hatched young and the adult fishes become a prey to predatory birds and mammals, and the result is a total loss. The rescue of this threatened population and its transference to a safe environment has assumed very considerable proportions. One worker reports that up to the end of August 1928, he had saved in his district of Hanford, 158,200 fishes, the majority of which were cat-fish, and these were planted in rivers throughout the country. During the month of August as many as 258,000 valuable angling fishes were saved to the State. Although a certain amount of useless and possibly harmful transportation has been carried out by enthusiasts, the aim of the Division of Fish and Game is to save only food-fishes, and to utilise them in stocking barren waters with the species most adaptable to their particular conditions.

Combat-Reactions in Frogs and Toads.—Reactions to special stimuli which produce specific phases of pose and movement suggesting a struggle, have been described amongst reptiles, but, according to Georg Hinsche, have not been suspected to occur amongst amphibians (*Biolog. Centralbl.*, Bd. 48, 1928, pp. 577-617). He finds a well-marked series of such reactions, twisting, staggering, stiffening, and kicking, suggesting attack and defence, to be exhibited by *Bufo vulgaris* and *Pelobates fuscus*, and rather less definitely displayed by other native amphibians such as *Bufo viridis*, *B. calamita*, *Rana esculenta* and *Hyla arborea*. Certain tactile as well as optical stimuli are adequate to set free such reactions, but along with the specific stimulus environment is an important factor. Hinsche considers that these combative reflexes are associated with very elementary reflex complexes related to the creature's food supply, burrowing habits, and sexual acts, and that, from the point of view of biological significance, they constitute a specific reply to a definite type of stimulus, and are not simply a reaction against an individual enemy. Their differences in degree in the different species he has experimented with are put down to differences in morphological and anatomical structure in these species. But in general the author finds that where a tendency towards flying leaps occurs, as in many species, the combat-reaction is reduced in intensity.

The Mosquitoes of North and South America. —Dr. H. G. Dyar, of the United States National Museum, has recently contributed an important revisional monograph entitled, "The Mosquitoes of the Americas." It is issued as *Publication of the Carnegie Institute of Washington*, No. 387 (1928), and brings up-to-date the many changes in synonymy that have taken place since the publication of Howard, Dyar, and Knab's standard four-volume treatise on the "Mosquitoes of North and Central America and the West Indies" (1912–17). It is, furthermore, to be regarded as being supplementary to the latter work, since it also includes all the known species from South America. The classification of the group has not been materially altered from that adopted in the larger monograph just mentioned, except that five tribes of these insects are recognised instead of two. The Sabethini are here regarded as a separate division, since the American species all exhibit the peculiar larval feature of the median ventral brush on the anal segment being wanting. Dr. Dyar's work will be found invaluable by special students of mosquitoes, since he describes in concise language the male, female, and larva of every species where material is available, and their salient structural characters are fully illustrated on the 123 plates which accompany this monograph.

Philippine Echinoids.—Mr. Hilario A. Roxas, in his paper "Philippine Littoral Echinoida" (*Philippine Journal of Science*, June 1928), reports on the littoral sea-urchins and sand dollars in the collection of the Department of Zoology, University of the Philippines. Echinoderms are not very numerous in the Philippines, but eleven species of sea-urchins and five of sand dollars (Clypeasteridæ, Arachnoididæ, Laganidæ, and Scutellidæ) have been found at Puerto Galera, Mindoro, which is the main collecting ground. The only really common species are *Tripneustes gratilla*, *Echinotrix calamaris*, and *Echinometra oblonga*, none of the others being abundant. Photographs are given of all the species, showing the main characters of the tests in most cases, both with and without the spines, which should make identification easy. *Prionocidaris verticillata* is a very striking form,

bright green when alive and having long heavy spines ornamented with whorls of projecting ridges.

FLOWER SIZE AND CHROMOSOME SIZE IN PETUNIA.—A peculiar genetic behaviour in Petunia is briefly described by Mr. E. Malinowski (*Jour. Heredity*, vol. 19, No. 11). He shows that in a variegated strain of *P. violacea* Lind. obtained from de Vilmorin, there is great variability in the size and colour of the flowers on some plants, other plants producing only large purple flowers or small lilac ones, and the same variable progeny being produced from seeds of any of the type. But plants cannot be inbred because of self-sterility. It is suggested that this range of variation, although phenotypical, is produced by the presence of one gene. It is further stated (and this needs confirmation) that the large purple flowers show larger chromosomes in their cells than the small lilac flowers, although in any one flower bud the meiotic divisions may show some cells with large and others with small chromosomes. The statement is also made that, following the reduction division, one of the daughter cells may have large and the other small chromosomes. It is suggested that the differences in flower size may be the result of the difference in size of the chromosomes. The whole subject requires fuller investigation, which might yield significant results.

DIŒCISM IN THE GARDEN ASPARAGUS.—A paper on the degree of diœcism in the garden asparagus by T. Shoji and T. Nakamura, in the *Japanese Journal of Botany* (**4**, 125-152; 1928), raises many points of general interest. In male plants the pistil was developed in the flowers to an extent that varied with the individual plant, but was very constant in the flowers upon any one plant. In the male flowers, instead of the typical trilocular ovary, bi- or unilocular ovaries may be found, and in some cases one carpel is modified into an anther. An interesting test is made of Robinsohn's reagent for determining the receptivity of the stigmatic surface for pollen, by the extent to which it stains when immersed in a aqueous solution of sodium potassium tartrate and silver nitrate. According to Robinsohn, the stigma should only stain deeply when it is in a receptive state, and tests of the normal pistils of asparagus were in accordance with this statement. On the other hand, heavy staining of certain regions of the imperfect pistils in the male flowers, which were quite without stigmas, rendered the reagent useless in distinguishing between fertile and infertile carpels. Wounds at the surface of the carpels tended to take up the stain, and the authors raise the question as to whether the degree of staining with this reagent is connected with the extent to which the cuticle is interrupted at the stigmatic surface, itself a question of some general interest. Many details of the cytology of the degenerating mega- and micro-sporangia are given in this paper.

LAND SHELLS FROM THE WEST INDIES.—Dr. H. A. Pilsbry and E. G. Vanatta describe three new land shells from Tortuga Island and one from Haiti, whilst Dr. Pilsbry appends a paper on the species of *Lucidella* (subgen. *Pœniella*), including two new, from Haiti and Santo Domingo (*Proc. Acad. Nat. Sci. Philad.*, vol. 80). Figures illustrating both papers are combined on one plate. Fig. 17, which is stated to represent a form of *Cerion tortuga*, n.sp., differs so much from Fig. 15, the type, and Fig. 16, a coloration variety, as to suggest that, variable as these shells are, an illustration of some other species has accidentally been substituted when making up the plate.

CARBONIFEROUS BRACHIOPODS.—The first part of a monograph on British Carboniferous brachiopods, by the late Dr. Ivor Thomas, was published in 1914. The second part (*Mem. Geol. Surv. Gt. Britain, Palaont.*, vol. 3, pt. 1, pp. 1-217, plates i-xii, 1928) is the work of Miss H. M. Muir-Wood and deals with the *semireticulatus* and *longispinus* groups of *Productus* (*sensu stricto*), of which 41 species or varieties are described. The Producti can be divided into at least eight genera, namely, *Productus* (restricted), *Avonia*, *Buxtonia*, *Pustula*, *Overtonia*, *Sinuatella* (gen. nov.), *Proboscidella*, and *Etheridgina*; they include the largest brachiopod known, *Productus giganteus*, with a breadth of 300 mm. The shell of *Productus* was apparently anchored by means of spines, sometimes five or six inches long, which are developed on the larger valve. The Producti are very abundant in the Carboniferous, but afterwards diminished in numbers and became extinct at the close of the Permian period. The group is said to have been derived from a Strophomenid ancestor in the Ordovician or Silurian. The earliest British representatives are found in the Pilton Beds of North Devon (Upper Devonian or basal Carboniferous). Shells of the *semireticulatus* group make their appearance in the Zaphrentis zone and evolved rapidly, but during *Seminula* times conditions were unfavourable to the development of this group. A multitude of new forms appeared in *Dibunophyllum* times and includes some over-specialised species with a very limited range in time and space. The sudden disappearance and extinction of the Producti is thought to be due in part to the excessive secretion of carbonate of lime.

THE SHAP GRANITE.—An important contribution to the petrology of the well-known Shap Granite has been made by Dr. D. R. Grantham, with the collaboration of Dr. H. F. Harwood, who has made seven excellent analyses. The results appear in the *Proc. Geol. Assoc.*, pp. 299-331; 1928. The 'granite' is a composite intrusion made up of a suite of porphyritic biotite-granites allied to adamellite. The oldest solid product of the original magma appears to be a chilled peripheral facies of basic type and probably hybrid origin. This 'early basic granite' was disrupted by the ascent of the main intrusions, distinguished as Stages I. and II., within which it occurs as the inclusions hitherto regarded as 'basic segregations.' The main mass of the granite shows successive increase in porphyritic felspars and decrease in accessories. A fourth phase is represented by Stage III., dyke-like masses of granite still richer in phenocrysts. The inclusions in Stage II. comprise not only 'early basic' and Stage I. types, but also numerous blocks of hornfelsed andesites and (rarely) Coniston limestone. Evidence is brought forward to show that contamination of the original magma by reaction with, and assimilation of, the andesites of the country rock is beyond reasonable doubt. Dr. Harwood's analyses give practically a straight-line diagram from 'andesitic inclusions' to Stage II., and this alone is weighty evidence in favour of assimilation. Further joint work on the andesites themselves is in progress.

SOUNDING AT SEA.—The December issue of the *Journal of the Franklin Institute* contains an account of the methods used by the United States Coast and Geodetic Survey for the measurement of the depth of sea water, by Lieutenant J. H. Service, of the Survey Department. For soundings in water too deep for the hand line the sound-wave method in the form known as the 'fathometer' is most used. An electrically driven oscillator strikes a diaphragm under water outside the ship and the sound reflected from the bottom of the sea affects a microphone in a water tank inside the ship's plating below water level. In

series with the microphone is a neon tube which lights up when the reflected sound arrives at the microphone. The tube is placed behind a radial slit in a revolving disc in front of which is a circular dial marked in fathoms. The oscillator acts as the neon tube passes the zero of this scale, so that the depth is read at the end of the revolving slit when it flashes out red owing to the lighting up of the neon tube behind it. The speed of sound in sea water of salinity 35 parts per 1000 at the surface and at 0° C. is taken as 1450 metres per second. It increases 4 metres per second per degree rise of temperature, 3 per 100 fathoms depth, and 1 per part per 1000 increase of salinity.

STRONG ELECTROLYTES.—The revival of interest in the properties of strong electrolytes which followed the publication of the Debye-Hückel theory in 1923 shows no signs of falling off, and a further group of papers on this subject has appeared in the issue of the *Physikalische Zeitschrift* for Nov. 1. One of these, by M. Wien, on departures from Ohm's law, is of particular importance. An electrolyte has been shown to undergo a decrease in resistance when it is subjected to high electric stress. In relatively weak fields the increase in conductivity is approximately proportional to the square of the field strength; for larger fields, the rate of increase is linear; and finally, when an intensity of the order of a hundred kilovolts per centimetre has been attained, a new value of the conductivity is reached, which is several per cent above that for weak fields, and is practically unchanged by any further increase in the applied potential. These effects depend in a characteristic way upon the valencies of the ions in the solution, and the ultimate value of the conductivity corresponds, within the limits of experimental error, with the conductivity of the same electrolyte in a weak field at infinite dilution. These observations, together with some others made by M. Wien on the effects of alternating fields on electrolytes, have been discussed by G. Joos, and have been shown to be at least in qualitative accord with the newer versions of the Debye-Hückel theory.

LUMINESCENCE.—A report upon cathodo-luminescence and the luminescence of incandescent solids by E. L. Nichols, H. L. Howes, and D. T. Wilber, that has been issued as a *Publication of the Carnegie Institution of Washington* (No. 384), furnishes a valuable summary of the experimental work that has been carried out by the authors and others in this little-known branch of optics. Their object has been to bring together investigations on the relations between the emission of light from hot bodies, other than purely thermal radiation, and such phenomena as fluorescence and phosphorescence at lower temperatures. Some of their results are very surprising, for example, the frequent excess of the radiation over that from a black body at the same temperature, and in general they find that selective emission, when excited thermally, shows the effects characteristic of ordinary fluorescence. The position of the bands in the spectra is often, moreover, the same under the different modes of excitation, of which exposure to a hydrogen flame and to the light of an iron arc are two typical examples, and from the evidence that they have presented they conclude finally "that the luminescence superposed upon the incandescence of the various solids is simply a *fluorescence* in all essentials identical with that commonly excited by light, cathode rays, and other familiar agencies."

A MULTIPLE-DOME ARCH DAM.—A reinforced concrete dam of unusual design has recently been completed in a canyon of the Gila River, Arizona, U.S.A. The dam is for a reservoir for the storage of water for flood control and power supply and for the irrigation of some 100,000 acres of land held as a reservation for the settlement of certain Indian tribes. The dam is the subject of a well-illustrated article in the *Engineer* for Jan. 18, from which it will be seen that not only is it of unique design but it is also a handsome structure. Many single-arch and multiple-arch dams have been constructed, and in these inclined arches spring from the piers, each arch sustaining the vertical weight of water as well as its horizontal pressure. In the new Coolidge Dam, as it is called, these arches are replaced by dome-shaped structures something of the form of the half of a very thick eggshell cut along its major axis. In the Coolidge Dam there are four piers, 180 feet centre to centre, and from these spring three ferro-concrete domes which are 21 feet thick at the base and 4 feet thick at the crown. The height of the dam is 250 feet. The first of its kind, the dam was designed by Major C. R. Olberg, of the United States Indian Bureau, and in his description of it he states that the maximum compression stresses for the dome were fixed at 600 lb. per sq. in., and in the buttresses at 400 lb. per sq. in. At first sight the shuttering for the construction of such domes would appear to be a matter of great difficulty, and not the least interesting feature of the work was the method used by the contractors for this shuttering.

NITRALLOY STEELS.—The issue of the *Chemical Age* for Jan. 5 contains some interesting information concerning the case-hardening of steels by nitrogen. When iron and steel are heated in an atmosphere of ammonia, nitrogen is absorbed, and with special steels (nitralloy) a very hard surface is produced. The 'nitration' is carried out after machine finishing, since no deformation occurs, providing that all strains have been relieved by suitable heat treatment, but only a small regular swelling, for which due allowance can be made. The resulting hardness is 900-1100 on the Brinell scale (chromium vanadium steel, case hardened, being 742) and permits glass and quartz to be cut. The nitrated steels are capable of taking a mirror finish, and it is claimed that they show exceptional resistance to wear. They retain their hardness up to 500° C.

OXIDATION OF PYRITES IN COAL SEAMS.—The Safety in Mines Research Board has issued a report of an investigation by H. Macpherson, N. Simpkin, and H. Wild (S.M.R.B. Paper No. 47. London: H.M. Stationery Office; 1*s*. 6*d*.) recording an examination of the occurrence of pyrites and its oxidation by air, particularly in the Ravine seam of Lancashire. Their work supports the view that pyrites acts not so much by initiating combustion as by promoting disintegration of the massive coal. This disintegration is brought about by the volume change on oxidation and assists access of air to the coal substance itself, which can then take up oxygen and so become heated.

FIRING COAL DUST.—A paper, by T. N. Mason and R. V. Wheeler, issued by the Safety in Mines Research Board (S.M.R.B. Paper No. 48. H.M. Stationery Office. 3*d*.), records experiments on firing coal dusts in a steel gallery, 7½ feet in diameter. The results confirm the view that the inflammability of the dust increases with the content of volatile matter of the coal, inflammability being measured by the mean speed of the flame. Explosability—measured by the maximum pressure developed—is of the same order and in close agreement with the proportion of incombustible matter which must be mixed with the coal dust to suppress its inflammability.

High Pressure Gas Research.

AT the invitation of the governing body and the rector of the Imperial College of Science and Technology, a distinguished company assembled at the College on Jan. 21 to inspect the new equipment of the high pressure gas research laboratories and the work in other sections of the Department of Chemical Technology. An opportunity was thus afforded of observing the results of a consistent policy of fundamental research, conducted in the atmosphere of intellectual freedom traditionally associated with British universities, into matters which from their very nature form the prop and stay of important sections of the industrial structure. The Department, which was inaugurated in 1912 under the direction of Prof. W. A. Bone, now comprises three sections: (1) fuel technology, with refractory materials, combustion, and high pressure gas reactions and explosions, retained by Prof. Bone under his immediate personal supervision; (2) chemical engineering, in the charge of Prof. J. W. Hinchley; and (3) electrochemistry, superintended by Assistant Prof. G. I. Finch. The breadth of its scope and aims has remained unchanged since its inception, the recent establishment of a special chair in chemical engineering being a natural consequence of the increasing size and influence of the department.

The work of the Department is exclusively of a post-graduate and research character, being chiefly directed to giving graduates in chemistry from the Imperial College or elsewhere a broad and practical training on fundamental lines; a training calculated to combine true intellectual development with an acquisition of the knowledge and skill required of holders of responsible positions in industry. In addition to the professorial staff there are three lecturers and an instructional assistant, whilst the personnel of the fine modern workshop consists of four skilled mechanics. The students (excluding sundry

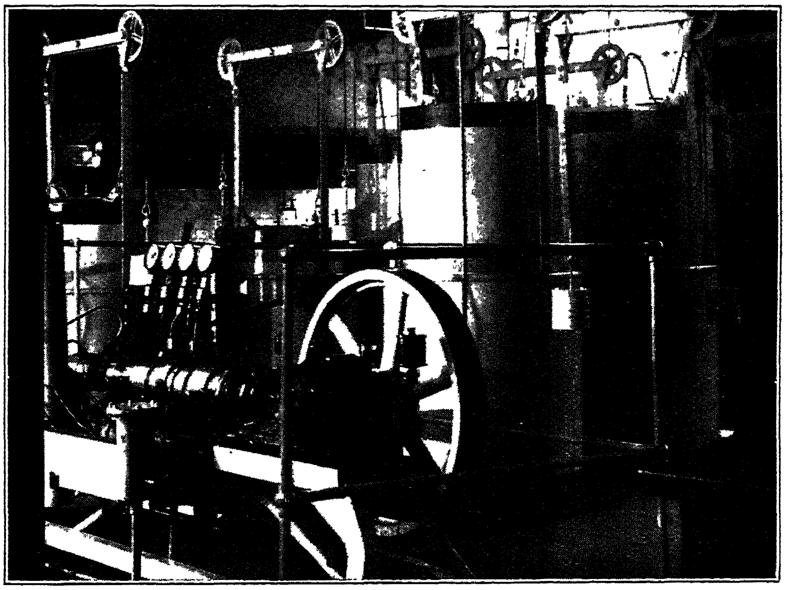

FIG. 1.—Gas-holders and the 1000 atm. 5-stage compressor.

occasional students) at present number 25, and there are 18 paid research assistants and fellows. The cost of the Department, in which there are thus 50 people continually prosecuting scientific and technological studies, amounts to about £13,000 per annum, of which about £7000 is defrayed out of the ordinary College funds, the remainder being in the form of aids and grants from various extra-mural sources. Of more than 150 post-graduate students who have already passed through the Department—some hailing from Australia, Canada, India, South Africa, the United States of America, China, or Japan—most now occupy responsible posts as fuel technologists, plant managers, chemical engineers, or research chemists in industrial concerns.

FIG. 2.—An explosion bomb with filling and optical recording systems.

The successful growth and operation of the Department has been achieved in buildings which, even after sixteen years, are far from complete. The first two stories (providing for fuel technology and in part for chemical engineering) were erected in 1913–14; after the War two further stories (for chemical engineering and electrochemistry) were added, but the continuous growth of the Department, and more especially its research developments, have rendered the present accommodation quite inadequate for the increasing needs of its work and activities. A scheme for the further enlargement of the building has therefore been approved, and will be carried out as soon as the necessary funds are forthcoming. The capital

expenditure on buildings and equipment to date has been approximately £60.000, and about £50,000 more is required for the extension now contemplated.

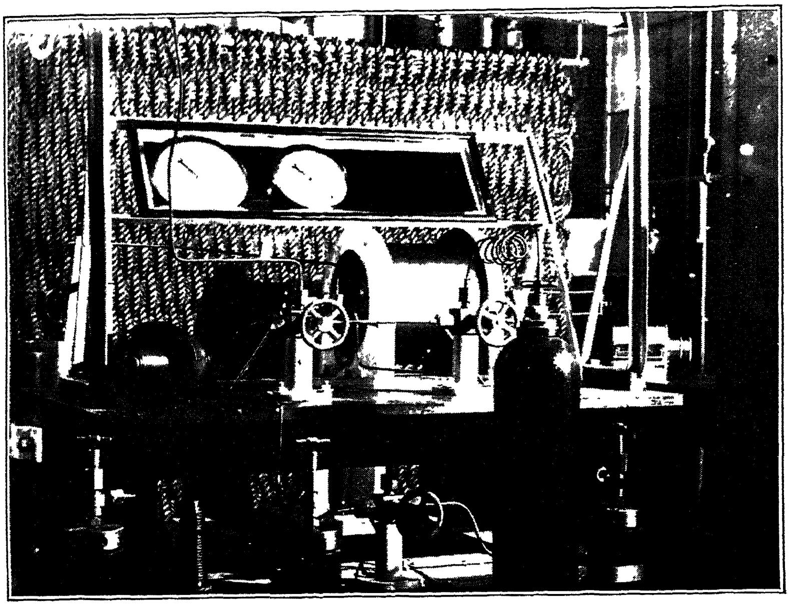

FIG. 3.—Bomb which withstands explosion pressures up to 15,000 atm., with filling system, mirror for reading gauges, and safety curtain.

It has been the constant policy of the Department to base its activities on a bedrock of fundamental research, and it now has a highly trained staff of research assistants who, organised in groups, prosecute systematic lines of research which are carefully planned in advance. After two terms, the student is attached for about a year to one of these groups, afterwards being allowed to proceed independently or to become a group-leader; he is thus disciplined in technique and accuracy, and he learns the value of co-operation and the benefit of leadership, whilst at the same time a continuity of skilled workers over a period of years is assured. Each of these men is, of course, supported by extra-mural grants or aids, and the leader, on passing out into the industrial world, immediately occupies the post which is awaiting him. During his period of leadership he has added to his scientific qualifications valuable experience in the control of technical men, in the preparation of weekly reports of progress, and in the discussion of his own and cognate researches at frequent and regular intervals, both with Prof. Bone and with his fellow group-leaders and researchers. It may be of interest to give a brief account of the principal lines of fundamental work which are being actively pursued in the Department.

CHEMISTRY OF COAL.

The group investigating, with the aid of grants from the Fuel Research Board and a fellowship maintained by the Sensible Heat Distillation Co., the chemistry of coal has already examined brown coals, lignites, bituminous, semi-bituminous, and anthracitic coals from all parts of the world. It has devised means for the extraction, by benzene at 250°, of the primary oils and the coking constituents of coals; this operation is naturally conducted in a separate fireproof shed. Much light has been thrown on the chemical aspects of the maturing of coals, and it has been found possible to oxidise the residue after extraction to about 40 per cent of its weight of benzenecarboxylic acids.

GASEOUS COMBUSTION AND REACTIONS AT HIGH PRESSURES.

The work on mixtures of air with carbon monoxide, hydrogen, or methane at initial pressures up to 200 atm.—itself of a pioneering nature—is, with the assistance of grants from the Department of Scientific and Industrial Research, Imperial Chemical Industries, Ltd., and the Gas Light and Coke Co., Ltd., being extended to initial pressures of 1000 atm. A single preparation of the pure gas affords 10 cub. ft., which is purified, collected in one of a series of small, distinctively coloured gas-holders, and then compressed in five stages up to 1000 atm. (Fig. 1); it is then stored in boldly painted cylinders —red (hydrogen), brown (methane), black (air), green (carbon monoxide), or yellow (helium); of 60 cub. ft. of the latter obtained from America four years ago, 35 cub. ft. remain. Every cylinder is numbered and records are kept of its use; one person is in charge of them, whether filled at 1000, 400, or 200 atm., and analyses each fresh charge. The

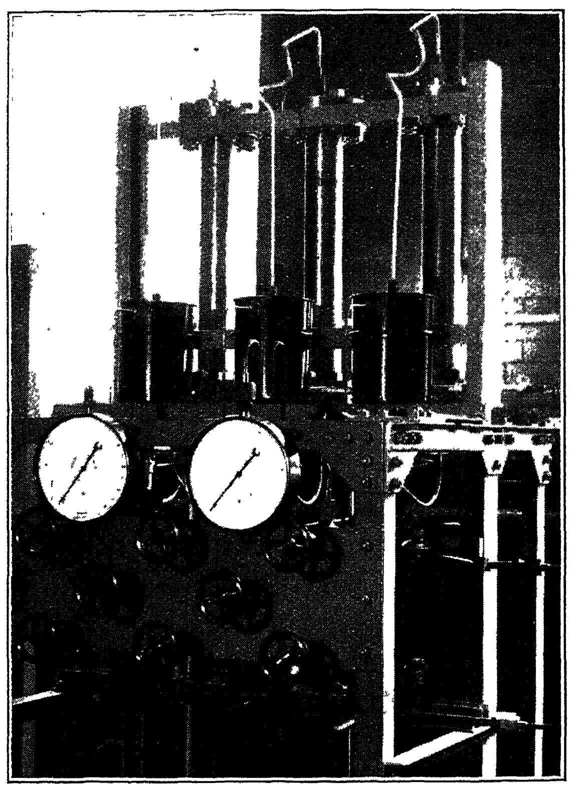

FIG. 4.—Multiple unit high-pressure catalytic circulating system.

most stringent rules guard, so far as is humanly possible, against accidents. Incidentally, the absence of exact data requires that compressibility measure-

ments be made on every gas mixture employed. There are three bombs for experiments employing up to 200 atm. initial pressure (Fig. 2)—the old bomb used by Prof. Bone at Leeds, a spherical bomb, and a cylindrical bomb with quartz windows for spectrographic work—and one, having 9-in. walls, wire-wound, and protected by thick rope curtains (the best known device), for experiments at initial pressures up to 1000 atm. (Fig. 3). This bomb is charged by a one-stage process with gas, and then by a two-stage process with air, in order to attain the requisite pressure; the charging is controlled from a distance, and the gauges are observed in a mirror. All the large apparatus, with the exception of the new 1000 atm. compressor, the compressor for catalytic experiments, and a few cylinders, which were made in Germany (from designs which, like those of most of the apparatus, were prepared by Dr. D. M. Newitt in consultation with Prof. Bone), are of British manufacture. Another new apparatus, with quartz windows, maintains steady continuous flames at pressures up to 100 atm. Experiments on the catalytic production of methyl alcohol in a single-tube unit will be extended with a new plant having three vertical catalytic tubes operated under 1000 atm. pressure at 600° C. (Fig. 4).

PHOTOGRAPHIC STUDY OF THE DEVELOPMENT OF GASEOUS EXPLOSIONS.

Supported by Nobel's Explosives Co., Ltd., this work has included the investigation of phenomena associated with the initial stages of gaseous explosions, and the influence of 'shock waves' in speeding up combustion and developing detonation, and it is now being extended to that of the influence of strong electrical and magnetic fields on flame-propagation in gaseous explosions. A novel form of camera designed by Mr. R. P. Fraser, and constructed for these researches, attains a film-speed of 200 metres per sec. A similar camera has been sent to Messrs. Nobel's at Ardeer, and another is to be despatched to the Australian Government.

COMBUSTION OF CARBON MONOXIDE, ETC.

With the aid of fellowships maintained by the Gas Light and Coke Co. and Radiation Ltd., the influence of moisture on the combustion of carbon monoxide has been shown to be essentially electronic. The limit of drying capacity of phosphorus pentoxide on a mixture of carbon monoxide and oxygen is attained in about 200 days, but however carefully dried, the two gases always explode if a sufficiently powerful spark is employed.

BLAST FURNACE REACTIONS.

These investigations, which are being carried out under the auspices of the National Federation of Iron and Steel Manufacturers, aim at studying each reaction fundamentally, and at the gas-speeds—up to 20 m.p.h.—actually obtaining in the blast furnace. In particular, the phenomenon of carbon-deposition, which occurs on interaction of ferrosoferric oxide and carbon monoxide, and at 450° by the change $2CO = C + CO_2$, but not above 650°, is being followed up with the view, broadly speaking, of discovering whether or not the deposition should be encouraged, and what factors influence its appearance. Such knowledge is a positively essential preliminary to any marked chemical advance in the manufacture of iron, and the results will be of great value in the characterisation of ores. To acquire them is costing some £1600 per annum.

SURFACE ACTION AND IONISATION.

Gaseous combustion in electrical discharges, and the electrical condition of surfaces during catalytic combustion, are under investigation. Work supported by the Department of Scientific and Industrial Research, and directed by Asst.-Prof. Finch, has already shown that combustion is conditioned by a prior 'ionisation' of both the combustible gas and oxygen.

CHEMICAL ENGINEERING.

Prof. Hinchley's section of the Department, in addition to providing systematic post-graduate instruction in the operation of chemical plant—instruction in which special attention is given to costing and to the actual construction of suitable units—is, with the support of the Distillers' Company, engaged in investigating fundamental problems connected with heat transmission and filtration. As soon as space is available, and further equipment installed, it will be possible to attack more adequately and systematically from a fundamental point of view the many problems encountered in the design and operation of chemical plant.

The Henri Poincaré Institute in Paris.

IN November last a new institute of mathematics and mathematical physics was formally inaugurated in Paris. It was both the official opening of a new building and the beginning of new courses of lectures, all to be a part of the Faculty of Sciences of the University of Paris. The building is now ready, but the internal arrangements are not yet complete.

The history of the new institute is brief. It had been noted by the International Education Board that on several occasions it had given large sums of money to different universities in Europe and that gifts to French universities had been on a much smaller scale. The importance of the French mathematical school suggested that help might usefully be given to mathematics in France. The decision was taken after consultations in which Prof. Trowbridge, who represented the International Education Board, and Prof. Birkhoff took leading parts. Prof. Émile Borel was asked to draw up a scheme. The plan, which was approved, provided for an institute to be named 'L'Institut Henri Poincaré,' as a centre for teaching and research on mathematical physics and the calculus of probabilities.

The courses on physical theories will be given in the new Institute by Prof. Léon Brillouin and M. Louis de Broglie. Prof. Léon Brillouin has made himself known by his researches on the theory of quanta and its applications; and he was invited last year to lecture in several universities of the United States and Canada. Dr. Louis de Broglie is one of the creators of wave mechanics, which now play a leading part in mathematical physics. These courses form an important addition to those already given in Paris by Prof. Brillouin and Prof. Langevin at the Collège de France, and by Prof. Eugène Bloch and Prof. Villat at the Sorbonne.

The calculus of probabilities already has its great exponent at the Sorbonne in Prof. Émile Borel. His researches on this subject have done much to revive interest in France in this subject, which owes so much to French workers such as Pascal, Fermat, Laplace, Poisson, Bienaymé, Cauchy, Cournot, Bertrand, Henri Poincaré. To Prof. Borel's course will now be added a new course by Maurice Fréchet, formerly professor of higher analysis at the University of Strasbourg. His theory of abstract spaces and functions has already made him known in the United States, where he delivered a course of lectures

at the University of Chicago in 1924. More recently, he has devoted much attention to the theory of probability, on which he has published (in collaboration with Prof. Halbwachs) "Le calcul des probabilités à la portée de tous."

The Henri Poincaré Institute will not, however, confine its attention to the new courses. It aims at being international in scope; in addition to the regular courses, single lectures or brief series of lectures will be given by distinguished scientific workers. Profs. Vito Volterra, of Rome, and de Donder, of Brussels, have already promised to co-operate.

The ever-increasing numbers at the Sorbonne has made additional accommodation necessary, and it was decided to erect a new building where not only the new courses but also all the advanced courses on mathematics will be given and where the mathematical library will be moved. The International Education Board is contributing one hundred thousand dollars towards these expenses; Baron Edmond de Rothschild has also contributed twenty-five thousand dollars, and the French Ministry for Education three hundred thousand francs. It is thus hoped to create in Paris a great scientific international centre for mathematical physics and calculus of probabilities.

Development and Morphology of Tunicates.

A RECENT issue of the *Quarterly Journal of Microscopical Science* (vol. 72, pt. 1) is entirely occupied by two memoirs on Tunicata. In the first, on the development of *Botrylloides* and its bearings on some morphological problems, by Miss Sylvia Garstang and Prof. Walter Garstang, uniformity in the purely ectodermal origin of the Ascidian atrium is established, which finally negatives the homology suggested by Van Beneden and Julin (1887) between the larval atrial canals of Ascidians and the spiracles of Appendicularians.

The investigation of the neuro-hypophysial system shows that the anterior part of the neural tube in front of the sensory vesicle undergoes a conspicuous development, and becomes longitudinally differentiated into two parts—a large ventral precerebral lobe which disappears entirely before the tadpole stage is reached, and a slender dorsal precerebral duct which persists and agrees essentially with the hypophysial duct of other Ascidians. This duct communicates with the oral region of the pharynx by a ciliated funnel, and gives rise to the brain by proliferation from its ventral wall.

It would appear that a considerable development of the pre-sensory region of the neural canal and its glandular modification was a primitive feature of the Tunicata, and distinguished them from *Amphioxus* and the Vertebrata. The comparative morphology and significance of the precerebral lobe is fully discussed.

The second paper is by Prof. Garstang alone. It is an interesting and speculative essay on the morphology of the Tunicata and its bearings on the phylogeny of the Chordata. He regards the current views of Tunicate ancestry—that the tailed larva represents the primitive or ancestral form from which the adult has been evolved by degeneration—as untenable. The neuro-muscular relations in Ascidian larvæ and Appendicularians are much more consistent with a theory of incipient than of vestigial metamerism and the development of atria before the gill-slits is in accordance with the phyletic history of the Protochordate type of gill-slit. The discontinuity between larval and adult nervous systems ("it is an error to assert that any part of the actual nervous system of the adult has formed a part of the larval nervous system") in Tunicates is unintelligible on the theory that Tunicates have been derived from *Amphioxus*-like ancestors, and points to a derivation of Tunicates from ancestors with a metamorphic life history before the typical chordate nerve-tube had come into existence.

The author has re-studied the symmetry of *Amphioxus*, which he explains as the consequence of the secondary *reduction of yolk in the egg entailing* premature hatching and the improvisation of a larval feeding mechanism. A great enlargement of the mouth and special ciliation of its entrance seem to form the basis of this mechanism, which involves a temporary dislocation of the adjacent parts and is held to have entailed changes which have left a mark on the permanent organisation of the adult. The author concludes that the ancestors of *Amphioxus* were essentially primitive Ascidians. In a future communication he proposes to deal with the origin of the chordate nervous system, and with the various cephalic organs associated with it.

University and Educational Intelligence.

LONDON.—The Senate has accepted an offer of the Committee of the Bayliss-Starling Memorial Fund of the sum of £2500 for the establishment at University College of a scholarship for training in physiology and biochemistry, to commemorate the connexion with physiology of the late Sir William Bayliss and Prof. E. H. Starling.

The following doctorates have been conferred: D.Sc. (in anatomy) on Mr. H. A. Harris (University College), for a thesis in the form of a series of memoirs dealing with the problems of bone growth, radiology, and teratology, published in various medical and scientific journals; D.Sc. (in botany) on Mr. W. B. Turrill (Chelsea Polytechnic), for a thesis entitled "The Phytogeography of the Balkan Peninsula"; D.Sc. (in chemistry) on Mr. Edgar Stedman (Birkbeck and Goldsmiths' Colleges), for a thesis entitled "The Relationship between Chemical Constitution and Physiological Action"; D.Sc. (in psychology) on Mr. J. C. Flugel (University College), for a thesis entitled "Studies in Mental Oscillation and Related Functions."

Dr. A. Sterling Parkes has been awarded the William Julius Mickle Fellowship for 1929 in respect of the work he has carried out during the past five years on the physiology and biochemistry of the organs of reproduction. The Fellowship this year is of the value of about £250.

Dr. G. P. Crowden has been appointed lecturer in applied physiology in the Division of Public Health at the London School of Hygiene and Tropical Medicine as from Aug. 1.

In March last a committee was appointed "To consider the question of the limitations placed upon the Medical Education of Women Undergraduates and to report to the Senate thereon." This report has now been issued. The problem was to provide clinical facilities for women requiring them in schools open to both sexes. The report points out that the prepossession of the University is in favour of co-education in medicine as in all other faculties, and suggests that there should be three types of clinical education: (1) for men only, (2) for women only, and (3) for men and women. The Senate has given general approval to the report, and schools of medicine not at present admitting women are to be invited to admit a quota of women students.

THE annual meeting of the Association of Technical Institutions will be held at the Grocers' Hall, London,

on Friday and Saturday, Feb. 22 and 23, under the presidency of the Right Hon. Lord Melchett. The programme includes papers by Sir Gerald Bellhouse, H.M. Chief Inspector of Factories, on industrial safety; by Mr. C. A. Siepmann, of the British Broadcasting Corporation, on broadcasting and its relation to technical education; and by Miss E. E. Cox, Principal, L.C.C. Barrett Street Trade School, London, on technical training for women. The Lord Mayor of London will entertain members and guests of the Association to luncheon on Feb. 22 at the Mansion House.

THE Commonwealth Council for Scientific and Industrial Research recently directed the attention of the Australian universities to the paucity of suitable candidates for the senior studentships in biological sciences which are being provided from the Science and Industry Endowment Fund. These studentships, if held abroad, are of the value (including fares) of £425 per annum for two years, and candidates are required to have given some evidence of capacity for original research work. To stimulate interest, it is now proposed to make available a number of junior studentships tenable either in the Council's laboratories or in Australian universities. They will be awarded to young graduates who have completed satisfactory courses but have not yet had sufficient opportunity to demonstrate their capacities for original work. At the end of their tenure the holders may become eligible for senior studentships abroad, or may perhaps be appointed to junior positions in one or other of the Council's research divisions.

"EDUCATION for Industry and Commerce" (H.M. Stationery Office, 6*d.* net) is the title of a pamphlet recently issued by the Board of Education. It is particularly timely in view of the reports of committees which, during the past three or four years, have touched upon the impact of scientific research and industrial development upon our educational theories. Already, arising out of those reports, Lord Eustace Percy has instituted two specific inquiries (salesmanship and engineering), and the present pamphlet, a survey of the arrangements at present in force for securing co-operation between technical schools and industries, is intended as an introduction to the new series of inquiries which are to be made into the organisation and methods of technical education. The pamphlet contains a preface by Lord Eustace Percy, which is an amplification of the detailed reply he made to the Emmott committee of inquiry into technical education and industry. It is a detailed view of the present educational facilities, but it is no mere tabulation. Especially worthy of attention are the passages dealing with the origin and purpose of our existing secondary schools. Referring to the Emmott committee's suggestion (which came from industry) that a memorandum should be prepared by the Board "covering the main features required in any technical training," the preface clears up one or two possible misunderstandings, but we still hope that such a memorandum will be issued, for without some national lead many employers find themselves in not a little difficulty. The arrangements for cooperation between industry and technical education are described in their two broad divisions—local arrangements under a local education authority, and the wider forms of co-operation on a national or regional basis. Developments since the War, such as the formation of joint industrial councils and research committees, are shown, as is also a useful list of places which have established advisory committees in specific subjects.

Calendar of Patent Records.

February 5, 1863.—The optical illusion known as 'Pepper's Ghost,' in which the images of living people could be projected on to the stage at will, and which proved an attraction at the Royal Polytechnic Institution for many years, was patented by Henry Dircks and J. H. Pepper on Feb. 5, 1863.

February 6, 1855.—The first 'artificial silk' patent was granted in England to George Audemars of Lausanne on Feb. 6, 1855. Audemars dissolved nitro-cellulose in an alcohol and ether mixture, and drew out threads from the solution by means of a steel pointer; the thread could be worked in the same way as silk and could be used as a substitute for it. It was not, however, until after many years of experiment and research that commercial success for the new thread was achieved by Chardonnet, the real pioneer of the vast industry of to-day.

February 7, 1589.—The art of papermaking reached Great Britain comparatively late. Down to nearly the end of the sixteenth century, our old linen cloths and rags were bought up by foreigners and all the best paper was imported from abroad. A very successful paper-mill was, however, set up by 1588 near Dartford, in Kent, by John Spilman, one of Queen Elizabeth's jewellers, who brought over workmen from Germany, and was granted a patent for ten years on Feb. 7, 1589, to make white writing paper. The patent was renewed in 1597 for fourteen years and extended to cover all kinds of paper, and the mill continued to work under different owners until well into the eighteenth century. Spilman was knighted by James I. in 1605, on the occasion of the King's visit to his works.

February 8, 1827.—The achievement of perpetual motion has been the aim of a multitude of inventors from Wilars de Honicort in the thirteenth century down to the present day, and some hundreds of patents for more or less ingenious machines have been applied for and granted in England. One of the most interesting of these was granted to Sir William Congreve, of rocket fame, on Feb. 8, 1827. An endless band of sponge runs round three rollers arranged in a frame at the angles of a right-angled triangle, and has attached to it on its outside an endless chain of weights so that the two bands move together—the parts of the chain and band being so uniform in weight that when the frame is placed with the hypotenuse upwards and the shorter side vertical, the system is in exact equilibrium. In this position the frame is placed in water with the lower part and two rollers immersed. The water is absorbed by the sponge on the vertical arm of the band because on that side it is not compressed by the weights, and the water will rise above its level and create a load that will set the band in motion.

February 8, 1841.—On Feb. 8, 1841, a patent was granted to W. H. Fox Talbot for his 'calotype' process of photography. This was the first process in which both a negative and positive were employed, and in which, therefore, a number of prints could be obtained from the one sitting. Talbot's process was cheaper than Daguerre's, which had been patented in Great Britain two years earlier, but did not give such clear impressions and was not very extensively used.

February 8, 1898.—Aspirin was put on the market as a drug by the German firm Fr. Bayer, which applied for a German patent on Feb. 8, 1898. The grant was, however, successfully opposed and no patent was actually issued. A corresponding English patent was granted in December 1898.

Societies and Academies.

LONDON.

Royal Society, Jan. 24.—D. Denny-Brown: (1) On the nature of postural reflexes. Postural reflexes are all based on Liddell and Sherrington's stretch-reflex. This basic reflex is a discharge of motor impulses at a slow rate, and no mechanical plastic or fixing mechanism is involved, except contraction caused by those impulses. The magnitude of reflex response changes by alteration of number of nerve units in discharge. This is effected by variations in excitation of units, either from changes in tension on muscle or from changes in excitatory effect relayed from higher levels of nervous system.—(2) The histological features of striped muscle in relation to its functional activity. Speed of contraction is a property of muscle fibres independent of observable histological differences, although development of rapid contraction occurs in fibre groups which are more highly differentiated for storage of lipoid substances or factors increasing fibre diameter.—W. S. Stiles: The effect of glare on the brightness difference threshold. A method is described for determining brightness-difference threshold in presence of point-source of glare. The value, for two subjects, of Fechner's fraction in absence of glare has been found for field brightness 0·001–2·2 candles/sq. ft. Threshold in presence of glare source is best expressed in terms of equivalent background brightness and a formula is developed which serves over this range.—L. J. Harris: The combination of proteins, amino-acids, etc., with acids and alkalis. Part 2. Titration curves of amino-acids, in presence of formol. Curves are given for variation in *p*H value (colorimetrical) with amount of soda added when amino-acids are titrated in aqueous formaldehyde, each addition being corrected for the acidity of the 'solvent.' The hydrochloric acid titration curve remained virtually unchanged by addition of formaldehyde. The results are explained on the basis of the 'zwitterion' hypothesis, according to which the caustic soda and hydrochloric acid titrations relate not to the apparent, but to the *true*, basic and acidic constants.—F. W. R. Brambell and G. F. Marrian: Sex-reversal in a pigeon (*Columba livia*).—J. B. Gatenby and Sylvia Wigoder: (1) The effect of X-radiation on the spermatogenesis of the guinea-pig. X-radiation prevents mitosis in those cells entering prophase. It is suggested that the X-radiation breaks up lipoids in some way essential to mitosis. Mild doses cause only temporary interference with lipoid metabolism, so that cells not already entering prophase of mitosis are able to recover. No evidence of stimulation effects by X-rays was procured.—(2) The post-nuclear body in the spermatogenesis of *Cavia cobaya* and other animals. In probably all flagellate sperms, the flagellum is fixed to the nucleus, not by the head centrosome, or by a protoplasmic membrane, but by a special structure called the post-nuclear body. This has often been mistaken for centrosome, middle-piece, or acrosome. It is a separate and distinct structure which (especially in molluscs) can be traced back into the spermatocyte.—J. B. Gatenby: Study of Golgi apparatus and vacuolar system of *Cavia*, *Helix*, and *Abraxas*, by intra-vital methods.—A. B. Macallum: Ionic mobility as a factor in influencing the distribution of potassium in living matter.

DUBLIN.

Royal Dublin Society, Dec. 18.—W. R. G. Atkins and H. H. Poole: The integration of light by photo-electrolysis. A vacuum sodium photoelectric cell of the Burt type was used. It was found possible to detect the production of alkali within ten seconds in daylight. The action of light may be integrated by titrating the alkali produced by a standardised cell. The deposition of copper appears preferable for longer periods, about 0·13 mgm. being deposited in a winter day; the potassium ethyl xanthate method serves for the estimation of the copper.

EDINBURGH.

Royal Society, Jan. 7.—H. S. Allen: Remarks on band spectra. A review of recent progress in the interpretation of band spectra. It is now known that band spectra originate in molecules containing more than one atom. Emphasis is laid on the close similarity between the electronic levels of molecules and those of 'corresponding' atoms, *i.e.* atoms with the same number of outer electrons. The application of the new quantum mechanics has removed outstanding difficulties as regards quantum numbers in band spectra.—Ian Sandeman: The Fulcher bands of hydrogen. An examination of Richardson's arrangement of these bands in the light of recent accurate measurements of the hydrogen spectrum by Gale, Monk, and Lee, while strongly confirming Richardson's allocation of the Q branches, has failed to yield confirmation of the remaining branches which he gives. A number of new combination relations holding between the lines of the Fulcher bands are given. These indicate that there are three main branches in each band, designated the R', Q, and P' branches, the Q branch being identical with that of Richardson. The R' and P' branches have a common initial level differing from that of the Q branch, while all three branches have a common final level.—F. B. Hutt: (1) On the relation of fertility to the amount of testicular material and density of sperm suspension in the fowl. Fertility in the male and the number of spermatozoa per cubic centimetre of semen are not determined by the amount of testicular material present. In cases of unilateral castration in which testis grafts had been implanted, the remaining testis did not undergo hypertrophy.—(2) The frequencies of various malpositions of the chick embryo and their significance. Of 39,760 eggs incubated, 11,797 which failed to hatch were examined. Of these, 5050 contained embryos that had died after the eighteenth day of incubation. In 56 per cent of these cases the chick had assumed an abnormal position within the shell, and this malposition was responsible for death. The malpositions seem to follow upon an incorrect orientation established by the first few cleavage divisions.—F. B. Hutt and A. W. Greenwood: (1) Chondrodystrophy in the chick. Among 7135 embryos of nine days or older found dead in the shell, 112 cases of chondrodystrophy were encountered. From 1900 eggs incubated, 124 chondrodystrophic embryos were obtained. The condition is greater in January and February, and thereafter declines to an almost complete absence in June. It is hereditary and expressed under certain unfavourable environmental conditions, such as lack of direct sunlight.—(2) Chick monsters in relation to embryonic mortality. Among the 11,797 dead-in-shell examined, 433 monsters were encountered. Hyperencephaly, exencephaly, and microphthalmia provided 93 per cent of these. Both sexes were equally affected. The incidence of these monsters was highest in February and thereafter declined. Chilling of the egg in the early stage of gastrulation seems to be a cause of arrested development observed.—L. A. Harvey: The oogenesis of *Carcinus mœnas* Penn., with special reference to yolk-formation. Observations on yolk-formation in *Carcinus mœnas* support the idea that yolk is formed not by the solitary action of the

various components of the cell, as has for a long time been considered to be the case, but by the interaction of the majority of the constituents of the egg. Probably the extent to which the different elements participate varies in different families, orders, etc., but fundamentally the same method of yolk-formation is present in all animals, as would be expected on an evolutionary theory.—**John Wishart**: The correlation between product moments of any order in samples from a normal population. A new method of determining sample moments exactly in semi-invariant form up to any desired order and from any population the moments of which are known, is applied to the particular case of a normal population, and the correlation between all product semi-invariants of the same order in two varieties is reached.

PARIS.

Academy of Sciences, Jan. 2.—H. Deslandres: Simple relations between the most intense and the highest radiations of the chemical elements in the bright atmosphere of the sun.—**L. Léger**: A mycetogen pseudo-tumour of alimentary origin causing an obstruction in the stomach of the trout. The pseudo-tumour was found to consist of a mass of undigested material covered with a growth of the fungus *Ichthyphonus intestinalis*.—**Paul Delens**: The calculus of spherical operations.—**Marcel Vasseur**: Deformable surfaces with a persistent conjugated conical network.—**Nicolas Cioranesco**: The problem of Dirichlet for systems of partial differential equations of the second order.—**J. Delsarte**: Oblique co-ordinated systems in functional space.—**T. Bonnesen**: Linear approximations.—**Georges Calugaréano**: The determination of the exceptional values of integral and meromorph functions of finite order.—**N. Podtiaguine**: Regular functions of higher order than two.—**S. B. Nicholson and Nicolas G. Perrakis**: The presence of the absorption line D_3 in the solar spectrum. The atmospheric line A (5875·603) is so close to the D_3 line (5875·620) that it is possible that the two have been confused by earlier workers. An account is given of observations, utilising the 43 cm. telescope of the Mount Wilson Observatory, for which the dispersion of the first order spectrum is 1 mm. = 0·72 A. The atmospheric line makes visual observations uncertain, but definite results could be obtained from photographs, making use of a modified Koch microphotometer. The dark line D_3 has only been observed in the regions covered with faculæ in the absence of visible spots.—**R. Swyngedauw**: The variation of the velocity and of the tension of a pulley belt along the pulley.—**Thadée Banachiewicz**: The ellipticity of the terrestrial equator.—**J. Kampé de Feriet**: A necessary condition for the absence of negative pressures in a perfect plane fluid in permanent movement round an obstacle.—**Henri Villat**: Concerning the sign of the pressures in a perfect fluid.—**R. Darbord**: A mercury and oil manometer. A description of a simple form of two-fluid manometer, suitable for pressures over the range of a few millimetres to some centimetres of mercury and possessing fifteen times the sensibility of a plain mercury manometer.—**R. Audubert and Mlle. M. Quintin**: The mechanism of the unsymmetrical conductivity of imperfect contacts. The hypothesis of electronic emissions accompanied by ionisation phenomena leads to a qualitative and quantitative interpretation of the unsymmetrical conductivity of imperfect contacts of silicon, and probably also of the mechanism of the silver sulphide and lead sulphide detectors.—**Jean Thibaud**: Longitudinal magnetic actions on bundles of slow electrons (concentrations and periodic expansions).—**Marcel Cau**: The double refraction and dichroism of thin layers of iron obtained by distillation.—**Ch. Bouhet**: The elliptical polarisation produced by reflection at the surface of solutions of the fatty acids in water. The results described, shown graphically for acetic, propionic, butyric, and valeric acids, agree with Langmuir's hypothesis. The molecules of fatty acids are, for these solutions, arranged with the hydrocarbon chain placed perpendicularly to the surface of the liquid.—**Pierre Daure**: The secondary radiations observed in the molecular diffusion of light (Raman effect). Results of observations on solutions of the chlorides of antimony, bismuth, magnesium, and aluminium, calcium bromide, liquid ammonia, and liquid methane.—**J. Gilles**: The structure of the third order spectrum of sulphur (S III.).—**Mme. Irène Curie**: The measurement of the active deposit of radium by the penetrating γ-radiation. The fraction K of ionisation attributable to radium-B, when radium-B and -C are in radioactive equilibrium, has been determined by Slater for varying thicknesses of lead. These results are now confirmed by a totally different method, and Slater's curve can be used to apply the necessary correction in the measurement of radium-C', made with respect to a radium standard.—**P. Fallot**: The secondary of the subbetic massifs between Moratalla and the edge of the Betic zone.—**Maurice Blumenthal**: The tectonic relations between the Betic of Malaga and the Betic of Granada.—**A. Demay**: The tectonic rôle of the granites and granulites of the western edge of the Sainte-Etienne coal basin.—**Louis Dangeard**: Circles of large pebbles observed at Jan Hagen Island.—**G. Chalaud**: The spermatozoid of *Cephalozia bicuspidata*.—**F. Obaton**: The origin and evolution of mannitol in plants. The study of the evolution of mannitol in two plants, *Sterigmatocystis nigra* and celery, proves that its function is that of a reserve substance; the alcohol appears to play the same part as saccharose and trehalose, but its formation is not in direct relation with the two latter substances.—**R. Combes and M. Piney**: Proteolysis and proteogenesis in ligneous plants at the commencement of the active period of growth.—**Marc. Simonet**: New researches on the number of chromosomes in the hybrids of the garden iris (*Iris germanica*).—**Aug. Chevalier**: The degradation of tropical soils caused by bush fires and the regressive plant formations which are the consequence of it. A discussion of the effects of bush fires, leading to production of soils either sterile or only capable of supporting certain useless plants.—**Louis Semichon**: The vesicular cells in *Anomia ephippium*.—**Alphonse Labbé**; The pallial sensorial organs in *Rostanga coccinea*. The dorsal part of the mantle of *Rostanga coccinea* is covered with small tubercles, hitherto described as simple conical papillæ. These are, in reality, complex sensorial organs, of unknown function.—**Remy Collin**: The passage of hypophysial cells in the cephalorachidian liquid of the infundibular cavity.—**Ch. Pérez**: Sexual characters in *Macropodia rostrata*.—**Tchang-Yung-Taï**: The localisation of intestinal absorption and the behaviour of the absorbent cells in the caterpillars of *Galleria mellonella*.—**J. Legendre**: The competition between zoophile and anthropophile mosquitoes. In an earlier paper an account was given of a race of mosquitoes avoiding man. These replace the mosquitoes attacking man when both are in the same locality, and this biological method of fighting the mosquito attacking man is suggested as worthy of trial.—**P. Wintrebert**: The digestion of the internal tubular envelope of the egg by ferments proceeding from the spermatozoids and the ovule in *Discoglossus pictus*.—**P. Reiss and E. Vellinger**: The potential of the arrest of egg-division in the sea-urchin.—**E. Gabritschevsky**: Compensation and regeneration in *Thomisium onustum*. Phenomena

of reversion and of accelerated evolution of the tegumentary characters under the influence of regeneration.—**Marcel Duval**: The proportion of carbon dioxide in the blood of the snail, *Helix pomatia*, in the course of the annual cycle. The amount of carbon dioxide is relatively slightly influenced by the state of activity of the animal.—**R. Fosse** and **Mlle. V. Bossuyt**: The quantitative analysis and characterisation of allantoin. The allantoin is hydrolysed, first in alkaline solution to potassium allantoate, and then in acid solution to glyoxylic acid and urea; the urea is determined as the xanthydrol compound.—**A. Machebœuf**: Researches on the phospho-aminolipides and the sterides of blood plasma and blood serum.—**A. Blanchetière**: The hydrolysis of egg albumen by trypsin in relation with the formation of the diacipiperazines.—**André Lwoff**: The nutrition of *Polytoma uvella* (Chlamydomonadinæ flagellate) and the power of synthesis of the heterotroph Protists. The mesotroph Protists.

CAPE TOWN.

Royal Society of South Africa, Oct. 17.—**James Moir**: An empirical formula for the absorption-bands of ammonia, phosphine, and arsine (Robertson and Fox) in the near infra-red. The formula is that of a fundamental wave-number multiplied by a vulgar fraction, the denominator of which depends on the gas: the result is modified by small corrections involving constants and integers.—**Th. Schrire** and **E. G. Greenfield**: On some new species of organisms isolated from *Xenopus Lœvis*. Three new organisms have been isolated from a spontaneous abscess in a frog. One is of an Anthracoid nature, and is extremely pathogenic to frogs and guinea-pigs. No toxin could be isolated from this organism.—**J. W. C. Gunn**: The susceptibility of the African chameleon to digitalis bodies. Amongst cold-blooded animals, the grass-snake and the toad (*Bufo*) are tolerant of very much larger doses than the frog (*Rana*). The South African clawed toad (*Xenopus lœvis*) is, on the other hand, susceptible to the same degree as *Rana*. Solutions of strophanthin, and tinctures of digitalis, squills, and strophanthus, were tested on *Xenopus* and *Chameleo* at the same time. The symptoms in the chameleon are similar to those observed in the frog. The heart is slowed and finally stops, with the ventricle in complete systole and the auricles engorged. Pallor of the skin was noted in 40 per cent of cases. The chameleon reacts to digitalis bodies like the frog, and does not show any special tolerance like the grass-snake.—**H. Zwarenstein**: The excretion of creatine in *Xenopus Lœvis*. The urine was collected by keeping 10 frogs in a glass receptacle for from one to five days. Pure urine was obtained by tying the skin around the anus and releasing the ligature every 24 hours. The results indicate that *Xenopus* excretes creatine, but not creatinine. The amount excreted is about 0·04 mgm. by each frog in 24 hours. 100 c.c. of pure urine contains about 2 mgm. creatine.—**N. E. Brown**: Contributions to a knowledge of the Transvaal Iridaceæ.

ROME.

Royal National Academy of the Lincei: Communications received during the vacation.—**G. Giorgi**: The sufficiency of the differential equations of mathematical physics. Ritz's criticism (1908) of the electromagnetic theory based on differential equations of the field is refuted, it being shown that, in the classical interpretation of the problems of mathematical physics, the insufficiency is not in the differential equations, but in the accessory conditions. If these are modified and the functional condition equivalent to that of succession is introduced in place of one of the conditions of the Cauchy type or of the infinity condition, integrals are obtained which are determined by the data usually presented in the effective problems.—**L. Lombardi** and **P. Lombardi**: Measurement of the local dissipations of energy in a circumscribed part of the magnetic circuit. Details are given of an apparatus for the measurement in watts of the energy dissipated in a circumscribed part of the magnetic circuit, use being made of two induced windings, connected respectively with the two coils of an electrodynamometer and employed for measuring, one the principal flux, and the other the magnetomotive force used to maintain it in the core.—**A. Angeli**, **D. Bigiavi**, and **Zwi Jolles**: Scission of certain sulphohydroxamic acids. The fact that, when sodium hydroxylamino-sulphonate and benzaldehyde react, the detection of the hydroxamic acid formed by means of the violet coloration with ferric chloride is unsatisfactory, rests, according to Raschig, on the necessity of using a large amount of alkali and the temperature 70° to effect the decomposition of the sulphonate. The authors find, however, that this reaction proceeds rapidly at the ordinary temperature and that the non-appearance of the coloration with ferric chloride is due to the reduction of this reagent by the sulphite liberated.—**P. Vinassa**: The fusibility of the elements and the electronic number. Irregularities are observed when the fusibility of the elements is considered as a periodic function either of the atomic weight or of the atomic volume. If, however, the absolute melting-point is divided by the electronic number, the result, termed the coefficient of fusion, ϵ, is an exact multiple of 0·5 for all elements, or, if the value obtained for helium is doubled, integral numbers. According to this relationship, the element solidifying at 0° absolute should have a zero electronic number, that is, should consist of proton alone.—**T. Boggio**: Bianchi's identity and gravitation homograph. In continuation of the ideas developed in recent communications, a new and very simple demonstration is given of Bianchi's identity for the derivative of Riemann's homograph. Further, application to the calculation of the vector gradient of Riemann's homograph leads to Einstein's gravitation homograph, the gradient of which is zero.—**Silvia Martis in Biddau**: Investigation of a rational expression for the powers of a matrix of the second order.—**G. Supino**: Certain limitations valid for harmonic functions.—**A. Tonolo**: Studies of the metric geometry of surfaces of linear four-dimensional space.—**G. Colonnetti**: New contribution to the theory of elastic co-actions and to its technical applications (2).—**B. Rossi**: Study of the electric field in homogeneous anisotropic media. Application of the theory of vectorial homographs to the problem of the electric field in anisotropic media greatly simplifies the treatment and often leads to a ready determination of the field.—**A. Carrelli**: A new phenomenon of diffusion. If the Raman effect is regarded as diffuse radiation foreseen from the quantistic theory of diffusion, the intensity of the Raman light becomes much less than the ordinary intensity. The number of lines observed depends on the number of characteristic frequencies of the monads in the ultra-red, but if the interpretation suggested is correct, the diffuse light should exhibit frequencies greater than the exciting frequency, the intensity of which is, however, less than that of the frequencies following Stokes's law.—**E. Persico**: Optical resonance according to wave mechanics (2).—**G. Canneri**: The separation of pure yttrium from yttrium earths. A method of purifying yttrium based on the fractional crystallisation of its double carbonates gives satisfactory results.—**D. Bigiavi**: Relations between certain aromatic compounds. The analogous compounds, benzyl

alcohol, phenylhydroxylamine, and benzenesulphenic acid, containing groupings including respectively carbon, nitrogen, and sulphur atoms, are able to undergo simultaneous reduction and oxidation, yielding: toluene and benzoic acid (from benzaldehyde formed as an intermediate product); aniline and nitrosobenzene; thiophenol and benzenesulphinic acid. Toluene, aniline, and thiophenol also exhibit analogies in behaviour, since they are able to yield respectively dibenzyl, hydrazobenzene, and diphenyl disulphide on oxidation.—F. Rodolico: Phosgenite from Monteponi.

Official Publications Received.

BRITISH.

Proceedings of the Society for Psychical Research. Part 109, Vol. 38, December. Pp. 209-279. (London: Francis Edwards, Ltd.) 4s.

The National Institute of Agricultural Botany. Ninth Report and Accounts, 1927-28. Pp. 19. (Cambridge.)

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Kitts-Nevis, 1927-28. Pp. iv+25. (Trinidad, B.W.I.) 6d.

Leeds University. Report to the Worshipful Company of Cloth-Workers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing, during the Session 1927-28. Pp. 14. (Leeds.)

British Museum (Natural History). Picture Postcards. Set F22. British Trees: Alder. 2 cards in Colour and 2 in Monochrome. 6d. Set F23. British Trees: Wild Apple. 2 cards in Colour and 2 in Monochrome. 6d. Set F24. British Trees: Ash. 2 cards in Colour and 2 in Monochrome. 6d. Set F25. British Trees: Beech 2 cards in Colour and 2 in Monochrome. 6d. Set F26. British Trees: Sweet Chestnut. 2 cards in Colour and 2 in Monochrome. 6d. Set F27. British Trees: Horse-Chestnut. 2 cards in Colour and 2 in Monochrome. 6d. Set F28. British Trees: Sycamore. 2 cards in Colour and 2 in Monochrome 6d. (London: British Museum (Natural History).)

Quarterly Journal of the Royal Meteorological Society. Vol 54, No. 228, October. Pp. 287-360. (London: Edward Stanford, Ltd.) 7s. 6d.

The Ninety-fourth Annual Report of the Royal Cornwall Polytechnic Society New Series, Vol. 6, Part 1, 1927. Pp. xv+75+14. 5s. The Ninety-fifth Annual Report of the Royal Cornwall Polytechnic Society. New Series, Vol. 6, Part 2, 1928. Pp. xvi-xxviii+77-182+13. 5s. (Camborne.)

Union of South Africa: Department of Agriculture. 13th and 14th Reports of the Director of Veterinary Education and Research. Part 1. Pp. 729. 10s. Part 2. Pp. 731-1270. 10s. (Pretoria: Government Printing and Stationery Office.)

Transactions of the Mining and Geological Institute of India. Vol. 22, Part 3, October. Pp. 177-274+x+plates 27-48. (Calcutta.) 4 rupees.

Journal of the Royal Microscopical Society. Series 3, Vol. 48, Part 4, December. Pp. xvi+379-503. (London.) 10s. net.

Society of Chemical Industry: Chemical Engineering Group. Proceedings, Vol. 9, 1927. Pp. 147. (London.) 10s. 6d.

Journal of the Indian Institute of Science. Vol. 11A, Part 10: i. Studies on Soil Protozoa, Part 1: Protozoan Fauna of some Mysore Soils, by H. S. Madhava Rao; ii. Studies on Soil Protozoa, Part 2: The Function of Mitochondria in some Soil Protozoa, by H. S Madhava Rao. Pp. 111-119+1 plate 1 rupee. Vol. 11A, Part 11: i Studies in Enzyme Action, Part 1: Amylase from Cholam (*Sorghum vulgare*), by V. N. Patwardhan and Roland V. Norris; ii. Studies in Enzyme Action, Part 2: The Nature of Amylase, by D. Narayanamurti and Roland V. Norris. Pp. 121-139. 1.8 rupees. (Bangalore.)

FOREIGN.

Spisy vydávané Přírodovědeckou Fakultou Masarykovy University (Publications de la Faculté des Sciences de l'Université Masaryk.) Čís. 96: "*Lonchopteris Jongmansi* nov. sp." z kamenouhelné panve rosickooslavanské ("*Lonchopteris Jongmansi* nov. sp." du bassin houiller de Rosice-Oslavany en Moravie (Tchécoslovaquie)) Napsal J. Augusta Pp. 11. Čís. 97: Pásmo porfyroidové ve Vrbenskem devonu na východním okraji Vysokeho Jeseníku (La zone de porphyroïdes dévoniens de Vrbno aux abords Est de Vysoký Jeseník en Silésie). Napsal Jan Stejskal. Pp. 34. Čís. 98: La refraction de l'hélium et de l'argon et sa dépendance des pressions inferieures à une atmosphère. Par Fr. Schacherl. Pp. 15. Čís. 99: La refraction de l'oxyde de carbone, de l'azote et de l'oxyde azoteux et sa dépendance des pressions inférieures à une atmosphère. Par. Fr. Schacherl. Pp. 29. Čís 100: Contribution à l'étude des propriétés projectives du contact Par Miroslav Konečný. Pp. 19. Čís. 101: Quod momentum significet *Carex pediformis* in stepposis silvaticis Europae mediae Scripsit J. Podpěra. Pp. 22. Čís. 102. Generis Trigonella L. revisio critica, I. Scripsit G. Sirjaev. Pp 57. (Brno A. Píša)

Spisy Lékařské Fakulty Masarykovy University, Brno, Československá Republika. Svazek 6, Spis 52-60. (Publications de la Faculté de Médecine, Brno, Tchécoslovaquie, Tome 6, Fascicule 52-60.) Pp. 64+40+8+6+14+21+12+61+24. (Brno: A. Píša) 40 Kč.

Biologické Spisy Vysoké Školy Zvěrolékařské, Brno, Československá Republika. Svazek 6, Spis 76-95. (Publications biologiques de l'Ecole des Hautes Études Vétérinaires, Brno, Tchécoslovaquie, Tome 6, Fascicule 76-95) Pp. 10+28+28+37+16+15+7+7+87+6+7+6+7+13+8+28+5+22+11+5. (Brno: A. Píša) 40 Kč.

Práce Moravské Přírodovědecké Společnosti, Brno, Československo. (Acta Societatis Scientiarum Naturalium Moraviae, Brno, Čechoslovakia.) Svazek 3, Spis 21-32 (Tomus 3, Fasciculus 21-32) Pp. 344 80 Kč. Svazek 4, Spis 33-41. (Tomus 4, Fasciculus 33-41.) Pp. 536. 100 Kč. (Brno: A. Píša.)

Sborník Vysoké Školy Zemědělské v Brně. ČSR. (Bulletin de l'École Supérieure d'Agronomie, Brno: RCS) Sign. C12 Mykologický rozbor rozkladu rostlinné hmoty a jeho význam pro praksi konservování píce (Analyse mycologique de la décomposition de la matière végétale et son importance pour la pratique de la conservation du fourrage). Napsal Dr. Miloš Bayer. Pp. 64+8 tabulkami. Sign C13: Příspěvek k rozšíření zoocecidií v Jugoslavii a zemích sousedních (Contribution à la distribution des zoocécidies en Yougoslavie et dans les pays voisins). Napsal Dr Eduard Baudyš Pp. [illegible] Sign. C14: Studie o významu štítné žlázy a brzlíku pro opěřování, vzrůst a jakost masa drůbeže (Studies on the Importance of the Thyroids and of the Thymus in the Feathering, Growth and Flesh-quality in the Poultry). Napsal Michail Nevalonnyj Pp. 137 Sign D9: Lesnické pokusnictví pěstební; Nástin soustavy a pracovních zásad (The Silvicultural Experimentation; a Short Outline of the System and Working Manner) Napsal Prof. Jos. Konšel. Pp. 52 Sign. D10: Stálost rostlinných buněk proti vyschnutí (La stabilité des cellules végétales contre la sécheresse) Napsal Prof. Vasil Sergějevič Iljin. Pp. 18. Sign. D11. Závislost přírůstku dřevní hmoty na obsahu ústrojných látek v půdě. Několik poznámek k práci A. Němce a K. Kvapila: Studie o chemické povaze profilů lesních půd. Napsal Alexandr Leporsky Pp 23. (Brno A. Píša.)

Methods and Problems of Medical Education. Eleventh Series. Pp. iii+263. (New York: The Rockefeller Foundation.)

Journal of the Faculty of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 24, Part 1: Beitrag zur Chemie der Haut (i. Die Hydrolyse in sauren und alkalischen Medien), von G Grasser, Dr. Sh. Taguchi und Sun Tau; Beitrag zur Chemie der Haut (ii. Einfluss der Ascher- und Beiz-Methoden auf die chemische Zusammensetzung der Blössen), von G. Grasser und H. Nakanishi; Die gerbenden Eigenschaften der Methylendinaphthole, von G. Grasser und K. Hirose; Die Reduction der Bichromate zu basischen Chromsalzen, von G. Grasser und T. Nagahama. Pp. 38. (Tokyo: Maruzen Co., Ltd.)

Diary of Societies.

FRIDAY, FEBRUARY 1.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10.30 A.M.—S. Scott: Vertigo.—A. R Tweedie: Some Notes on the Rotation, Caloric, and Galvanic Tests.—Dr A. L Yates: Demonstration of Some Graphic Records of Instability, illustrative of Cases referred to by Mr. Sydney Scott.

ANDERSONIAN CHEMICAL SOCIETY (at Royal Technical College, Glasgow), at 3 15.—Dr. R. Hay: Manufacture of Sulphuric Acid by the Contact Process

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 5.

ROYAL SANITARY INSTITUTE, at 5.—F. R. Humphreys and others: The Civilian Population and Chemical Warfare.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. C. A. Pannett: Local Anæsthesia in the Surgery of the Upper Abdomen.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—Prof. V. G. Childe: Philology and Archæology.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Prof A. S. Eddington: Engineering Principles in the Machinery of the Stars (Thomas Hawksley Lecture).

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (jointly with Liverpool Section) (at Engineers' Club, Manchester), at 7.—Dr. F. Challenger: The Sulphur Compounds of Shale Oil and Petroleum.

INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section), at 7.—J. L. Carr: Recent Developments in Electricity Meters, with particular reference to those for special purposes.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group—Informal Meeting), at 7.—P. Fripp Some Aspects of Craftsmanship.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (jointly with Institute of Chemistry) (at Thomas' Cafe, Swansea), at 7.30.—E. A. Tyler: Further Notes on Pure Chemicals.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—T. H. Cross: Notes on Road Construction.

TEXTILE INSTITUTE (Lancashire Section) (jointly with Nelson Textile Society) (at Nelson), at 7 30.—O. S. Hall: The Economic Aspect of some Developments in the Textile Industry (Lecture).

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Dr. R. D. Lawrence: Post-operative Acidosis

ROYAL INSTITUTION OF GREAT BRITAIN, at 9 —Prof. J. L. Myres: Geometrical Art in S E. Europe and Western Asia.

SATURDAY, FEBRUARY 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. E. Cammaerts: Flemish and Belgian Art (III.): Genre Painting.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch) (at College of Technology, Manchester), at 4.30.—J. O. Gray: Works Accounting and Foundry Practice.

MONDAY, FEBRUARY 4.

ROYAL SOCIETY, EDINBURGH, at 4.30 —Dr. Nellie B Eales: On the Anatomy of a Fœtal African Elephant *Elephas africanus* (*Loxodonta africana*): Pt 3—The Contents of the Thorax and Abdomen, and the Skeleton —A. D. B. Smith and J. R Brown: The Role of Inbreeding in the Development of the Jersey Breed of Cattle in England.—Dr. A. W. Greenwood and J. S. S. Blyth: Experimental Study of the Thyroid Gland in the Domestic Fowl, with Special Reference to Plumage Characterisation —*To be read by title only*.—Prof. C. W. Stump: A Human Blastocyst *in situ*.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4 30.—P. J. Le Riche Scientific Proofs of a Universal Deluge.

BIOCHEMICAL SOCIETY (at Lister Institute), at 5.—H. Chick and M H. Roscoe: (*a*) Methods for the Assay of Vitamins B_1 and B_2; (*b*) On the Separation of Vitamins B_1 and B_2 from Yeast.—M. H. Roscoe: Rats Reared Eight Months after Weaning on Diets Deprived of B Vitamins —T. Lumsden: The Effect of Various Reagents upon Cells Cultured *in vitro*.—L F. Hewitt: Hormones of the Anterior Pituitary Lobe.—N. F. Maclagan: The Use of Decinormal Hydrochloric Acid for

Standardising Electrometric pH Measurements.—E. Boyland: The Sequence of the Formation of Phosphoric Esters and Carbon Dioxide in Fermentation by Dried Yeast.—R. Robinson and E. King: Hexosemonophosphoric Ester.—E. King and W. T. J. Morgan: Methylated Derivatives of Hexosemonophosphoric Ester.—W. T. J. Morgan: The Constitution of Hexosediphosphoric Ester.—*Demonstrations* (*from 3.30*): —G. H. Eagles: Growth of Vaccine Virus in Tissue Culture.—A. Felix: Floccular and Granular Agglutination Phenomena.—T. Lumsden and A. C. Kohn-Speyer: Serum as a Culture Medium for Serological and Other Tests.—E. M. Hume, N. S. Lucas, and H. Henderson Smith: Three Common Marmosets (*Hapale jacchus* Linn.) Bred in Captivity with the Aid of Ultra-violet Irradiation.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. R. J. McNeill Love: The Treatment of some Acute Abdominal Disorders.

SOCIETY OF ENGINEERS (at Geological Society), at 6.—A. K. Dodds: Berwick's Bridges (Presidential Address).

INSTITUTION OF AUTOMOBILE ENGINEERS (Bristol Centre) (at Merchant Venturers' Technical College, Bristol), at 6.45.—Dr. F. W. Lanchester: Coil Ignition.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—W. R. Rawlings and others: Discussion on Earthing and the Safety of the Public.

RAILWAY CLUB (57 Fetter Lane) (Annual Meeting), at 7.30.—Presidential Address.

ROYAL SOCIETY OF ARTS, at 8.—Dr. C. H. Lander: The Treatment of Coal (Cantor Lectures) (III.).

SURVEYORS' INSTITUTION, at 8.—H. J. Vaughan: The Significance of the Timber Merchant in Estate Forestry.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.

TUESDAY, FEBRUARY 5.

ROYAL SOCIETY OF MEDICINE (Orthopædics Section), at 5.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the months of November, December 1928, and January 1929.—E. G. Boulenger: Remarks on the Behaviour of Certain Inhabitants of the Society's Aquarium.—G. C. Robson: On a Case of Bilateral Hectocotylisation in *Octopus rugosus*.—G. C. Robson and Prof. L. Joubin: On a New Species of *Macrotritopus* (Cephalopoda) obtained by Dr. J. Schmidt's *Dana* Expedition, with Remarks on the Genus.—W. N. F. Woodland: On a New Species of *Rhabdometra*, with a Note on the Nematodiform Embryos of *Anonchotænia globata* (Cestoda).—H. C. Wilkie: The Attachments of the Auditory Ossicles of the Common Mole (*Talpa europæa*).—Dr. H. Boschma: The Fungidæ (Anthozoa) collected by Mr. Cyril Crossland at Tahiti and Neighbouring Islands.—C. S. Garnett: Some Notes and Observations on the Flight of Flying-Fishes.

INSTITUTION OF CIVIL ENGINEERS, at 6.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at University College, Nottingham), at 6.45.—W. B. Woodhouse: Overhead Electric Lines.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—J. Wright and C. W. Marshall: The Construction of the Grid Transmission System in Great Britain.

INSTITUTE OF METALS (Birmingham Local Section) (jointly with Birmingham Metallurgical Society and Staffs. Iron and Steel Institute) (at Engineers' Club, Birmingham), at 7.—D. J. MacNaughtan: Electrodeposition.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates) (at Broadgate Cafe, Coventry), at 7.15.—R. A. Clapham: Free Wheels.

INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at Lamb's Restaurant), at 7.30.—Discussion on Earthed *versus* Insulated Systems.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.45.—H. K. Thomas: Some Investigations into the Performance of Tubular Radiators for Motor Vehicles.

HULL CHEMICAL AND ENGINEERING SOCIETY (at Grey Street, Hull), at 7.45.—G. H. Barron: Ice-making.

TELEVISION SOCIETY (at Engineers' Club, Coventry Street), at 8.—R. R. Poole: Methods of Light Modulation in Receivers.

WEDNESDAY, FEBRUARY 6.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. C. P. G. Wakeley: The Etiology, Pathology, and Treatment of Tumours of the Intestinal Tract.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: Evolution and the Problem of Species (II.).

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—E. St. John Burton: The Horizons of Bryozoa (Polyzoa) in the Upper Eocene Beds of Hampshire.—M. Black: The Upper Estuarine Series of Yorkshire.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Dr. B. Hodgson, L. S. Harley, and O. S. Pratt: The Development of the Oxide-coated Filament.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—Prof. T. P. Hilditch and Eveline E. Jones: The Fatty Acids and Component Glycerides of some New Zealand Butters.—A. S. Dodd: A New Test for Boric Acid and Borates.—B. E. Dixon: The Determination of Beryllium in Rocks.

ROYAL SOCIETY OF ARTS, at 8.—Sir J. Alfred Ewing: The Vibrations of Railway Bridges: an Example of Co-operative Research (Trueman Wood Lecture).

ROYAL SOCIETY OF MEDICINE (War and Surgery Sections), at 8.30.—Group-Capt. H. V. Wells (War), Sir Percy Sargent (Surgery), and others: Special Discussion on The Necessity for Early Diagnosis in the Treatment of Spinal Injuries.

ROYAL MICROSCOPICAL SOCIETY (Biological Section).

SOCIETY OF CHEMICAL INDUSTRY (Nottingham Section).—Dr. T. Callan: Simplified Methods of Electrometric Analysis.

THURSDAY, FEBRUARY 7.

ROYAL SOCIETY, at 4.30.—Sir Ernest Rutherford, Dr. F. W. Aston, Dr. J. Chadwick, Dr. C. D. Ellis, R. H. Fowler, and Prof. O. W. Richardson: Discussion on The Structure of Atomic Nuclei.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: The Early History of X-rays (II.).

CHEMICAL SOCIETY, at 8.—C. S. Gibson and J. L. Simonsen: Indian Turpentine from *Pinus longifolia* Roxb. Part V. The Oxidation of d-Δ^3-carene with Beckmann's Chromic Acid Mixture.—A. W. Chapman: A New Method for Preparing Substituted Diphenylamines.—C. S. Gibson, J. D. A. Johnson, and B. Levin: Compounds of the Tryparsamide Type. Part I. Resolution of N-phenylalanine-4-arsinic Acid and of its Amide.—C. S. Gibson and J. D. A. Johnson: 10-Chloro-5:10-dihydrophenarsazine and its Derivatives. Part VII. The Synthesis of the 1-methyl- and of the 3-methyl-homologues.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases Section), at 8.15.—Monkeys and Human Disease:—R. I. Pocock: Zoological Relationships of Primates (Apes and Monkeys).—R. Lovell: Bacterial Diseases.—E. Hindle: Virus Diseases.—Dr. J. G. Thomson: Protozoal Diseases.—T. W. M. Cameron: Helminthic Diseases.—Dr. V. B. Wigglesworth: Insect Diseases.—Col. A. E. Hamerton: Morbid Anatomy.

INSTITUTE OF CHEMISTRY (Manchester and District Section) (at Manchester).—Prof. C. K. Ingold: Mechanism of Atomic Structure: Significance of the Thiele Hypothesis.

SOCIETY OF DYERS AND COLOURISTS (West Riding Section).—A. J. Hall: The Action of Alkalis on Cotton and Artificial Silks.

INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Branch).

FRIDAY, FEBRUARY 8.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.—Capt. E. J. Headlam: The History of the Indian Marine.

ROYAL ASTRONOMICAL SOCIETY (Anniversary Meeting), at 5.—Presentation of the Gold Medal to Prof. E. Hertzsprung, for his Determination of the Distance of the Lesser Magellanic Cloud and other Pioneering Work in Stellar Astronomy.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—L. F. Stanley: The Construction and Calibration of a Sensitive Form of Pirani Gauge for the Measurement of High Vacua.—H. C. Webster: (*a*) Photographic Measurement of the Relative Intensities of the $L\alpha_1$, $L\alpha_2$, $L\alpha_3$ Lines of Silver; (*b*) Spark Satellites of the $L\alpha$ Lines of Silver.—Demonstration of a New Instrument for the Rapid and Accurate Determination of the Specific Gravities of Solid Substances, by W. A. Benton.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. R. T. Payne: The Treatment of Varicose Veins and Varicose Ulcers by Injection.

BRITISH PSYCHOLOGICAL SOCIETY (Æsthetics Section) (at Bedford College for Women), at 5.30.—Dr. H. Lowery: Musical Memory and Rhythm.

MALACOLOGICAL SOCIETY OF LONDON (at University College), at 6.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 6.—L. A. Legros and others: Discussion on The Profession of the Mechanical Engineer.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Newcastle-upon-Tyne), at 6.—Dr. G. W. Todd: The Prediction of the Properties of Engineering Materials from their Ultimate Structures.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—H. H. Taylour: Electric Welding.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Informal Technical Talk), at 7.—B. C. Wickison: Lantern Slides.

GEOLOGISTS' ASSOCIATION (Annual General Meeting) (at University College), at 7.30.—Prof. A. Morley Davies: Formal Migrations since the Cretaceous Period (Presidential Address).

INSTITUTE OF METALS (Sheffield Local Section) (at Sheffield University), at 7.30.—W. T. Griffiths: Some Recent Developments in Nickel Metallurgy.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Dr. A. E. Dunstan: Recent Developments in the Art of Oil Cracking (Lecture).

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Royal Society of Arts), at 8.—Prof. W. E. Gibbs: The Rôle of Surface Energy in Chemical Engineering.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—R. F. Moore and Mr. Scott: Clinical and Pathological Report of Bilateral Glioma Retinæ.—R. F. Moore: Cirsoid Aneurysm of the Visual Cortex.—B. Graves: Scleral Illumination.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—C. E. R. Sherrington: Recent Problems of Rail Transport at Home and Abroad.

SATURDAY, FEBRUARY 9.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. S. Marchant: Music in Cathedral and Collegiate Churches (I.).

MINING INSTITUTE OF SCOTLAND (at Edinburgh).

PUBLIC LECTURES.

FRIDAY, FEBRUARY 1.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—C. E. R. Sherrington: The Steam Railways and the Localisation of Industry in the Nineteenth Century.

SATURDAY, FEBRUARY 2.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: The Ancient Egyptian Potter and his Clay.

MONDAY, FEBRUARY 4.

KING'S COLLEGE OF HOUSEHOLD AND SOCIAL SCIENCE, at 5.15.—F. Rodd: Saharan Nomads.

EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—J. A. Venn: Some of the Causes of the Agricultural Depression and Suggested Remedies.

TUESDAY, FEBRUARY 5.

UNIVERSITY COLLEGE, at 5.30.—Julia Bell: The Handicapping of Men by Diseases transmitted by but not developing in Women.

FRIDAY, FEBRUARY 8.

LONDON SCHOOL OF ECONOMICS, at 5.—C. E. R. Sherrington: Railway Electrification and the Redistribution of Industry.

SATURDAY, FEBRUARY 9.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: Life Beyond the Low-Tide Mark.

NATURE

SATURDAY, FEBRUARY 9, 1929.

CONTENTS.

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Modern Witchcraft.

THE symposium on spiritualism which, as already noted in NATURE, the *Daily News* has been publishing, is of some importance even though it be merely an indication of the deplorable and sometimes almost pathetic attitude of prominent laymen towards the scientific method of approaching obscure problems. From the great majority of the articles submitted, it would seem that not only are the methods of science wholly misunderstood, but also that there is little appreciation of the meaning of evidence when applied to physical and psychological matters. This is the more surprising when we remember that prominent legal writers have contributed to the series, and aptly illustrates the fact that the human mind finds it difficult to apply the same standards of evidence to subjects which differ both in their general content and above all in their emotional significance.

The terms of reference under which the symposium was conducted were grouped under three heads. First came the question of deciding if the claims of spirit communications made by spiritualists are proved or disproved, or indeed if they can be proved or disproved. Secondly, the evidence or experience on which the writers' opinions were based was requested; and finally, a reply was sought to the question whether the growth of spiritualistic practices was likely to prove a menace or otherwise to mind or body. Apart from the confusion between 'spirit communications' and 'spiritualistic practices,' the terms are simple and, whilst not well adapted for scientific discussion, are broad enough for popular opinion. Moreover, the elasticity of the terms might have given the writers good excuse to present some of the evidence in detail, which would have been of interest to the general reader.

From this point of view, however, the symposium cannot be called a success. It must be clearly remembered that the scientific method is the only one properly applicable to these alleged supernormal phenomena. Theories based upon theological or philosophical speculation have little real value until the facts which underlie them are found to be so far related to the known that they can be properly described, and the phenomena concerned repeated at will, or at least adequately and repeatedly observed. Until this is done the alleged facts are themselves suspect. The believers in early witchcraft would have provided better evidence for their faith than that which the exponents of the modern variety have contributed to

this symposium. Statements are made and stories related without any sound evidence being adduced in their support. Similarly, the opponents of the spiritualists have to a great extent contented themselves with arguments which leave untouched the kernel of the problem. We are not concerned, for example, with whether alleged spirit communications are trivial or profound, sublime or ridiculous. To assert that, because in so many cases they are trivial and ridiculous, *therefore* they cannot proceed from spirits, is to assert that we have knowledge as to what spirit communications *ought* to be like, and no such knowledge exists. Again, when it is asserted that certain of the phenomena are explained by 'telepathy,' the statement has no meaning. Telepathy does not explain anything. It is merely a name invented to describe a supposed process concerning which we know nothing, not even that it exists.

Attempts have been made repeatedly to demonstrate experimentally the existence of telepathy. Probably the best known trials were those undertaken with Prof. Gilbert Murray acting as percipient. One might have supposed that, with so distinguished a collaborator, experiments would have been devised which would have had at least some relation to ordinary scientific procedure. Such, however, was not the case. The tests partook much more of the nature of parlour games, and we understand that suggestions for further and properly controlled experiments have been rejected. The same story echoes down the ages. The writers of the *Daily News* symposium have little to add to the questions of Porphyry and the answers of Iamblichus; the stories of St. Augustine and the caustic satire of Lucian. The problem was the same then as now. The excuses and subtle methods of the medium Alexander of Abonutichus were identical with those used to-day in the séance rooms of West London. In the circumstances, it is difficult to be surprised at the general attitude of modern scientific men who are apt to regard the witchcraft of to-day in the same light as they regard the witchcraft of yesterday, as a belief based upon fraud, delusion, and hypocrisy.

Now, whatever may be the truth underlying alleged supernormal phenomena, there is no doubt that an increasingly large number of persons believe in their reality. Even if such phenomena have never occurred, it is indubitable that human beings of all ages and times have reported them in terms of such remarkable similarity that it is difficult to believe that similar sets of circumstances have not originated them. For example, the stories of haunting phenomena have been so similar for hundreds of years that we cannot doubt that certain events do take place in certain houses which lead the occupiers to describe their experiences in the same way and to maintain that they are inexplicable. Now, apart from the question of the normal or supernormal character of the phenomena of haunting, these facts alone are worthy of the attention of science. What are precisely the circumstances which lead people in ordinary life to describe in detail the appearance of phantoms which are not rarely seen by more than one person at the same time? What are the conditions which lead persons widely separated in time and space to describe the appearance of showers of stones which seem to fall out of the air (the so-called stone-throwing poltergeist)? Again, how can we describe adequately those abnormal psychological mechanisms which result in cases of multiple personality, where certain of the so-called secondary personalities betray knowledge of persons and events which careful inquiry fails to prove could at any time have been within the normal content of the subject's mind? Precisely the same problem is presented regarding the beliefs of primitive peoples. Phenomena, inexplicable to the natives themselves, and also to European observers, have been reported from all parts of the world.

The *Daily News* symposium is some slight indication of how superstition and credulity are fostered on account of our ignorance of the origin and basis of these world-wide tales. We cannot doubt that a more complete and systematic investigation is desirable, but at the same time it would seem that it is not the duty of the ordinary scientific man to undertake researches in this field. The first necessity is a thorough knowledge of the art of mystification, and this implies a good acquaintance with those psychological factors underlying conscious and subconscious deception, pathological lying, false memory, number preferences, and similar conditions. The ordinary physicist does not possess any of these qualifications, and the results of lacking them can be observed if we study the amazing history of the *N*-rays to which Mr. Campbell Swinton alluded in his article in the *Daily News*.

The subject is at present outside the range of competent scientific inquiry, and thereby a mass of valuable information is being lost. Whatever may be the explanation of the belief in supernormal phenomena, we can scarcely deny that it has had an enormous effect upon the happiness and misery of mankind. Belief in these occurrences appears to

be increasing, and the only method of checking its progress or confirming its basis is the application of impartial, unemotional, and rigid scrutiny of the alleged facts by men trained to detect sources of error and possessing some knowledge of the history of the problem in its relation to human thought. Such inquiry, we think, cannot be much longer delayed. The symposium we have been considering is a fair indication of the chaos in the mind of the public, and the recent prosecution of a 'medium' by the State shows the same uncertainty and hesitation in the mind of the Government. An inquiry conducted on scientific lines would be a task of great magnitude and considerable difficulty. On the other hand, if the only result were to fail to find any evidence of 'supernormal' activity, a very important body of material would have been collected which must throw a good deal of light on the psychological questions involved in malobservation and error, not only in civilised peoples but also among the inhabitants of countries which have not at present wholly absorbed the culture of the West

The Making of an Epoch.

The Discovery of the Rare Gases. By Prof. Morris W. Travers. Pp. vii + 128. (London: Edward Arnold and Co., 1928.) 15*s*. net.

THE discovery of a new chemical element is a feat of a kind that is unique, and in one aspect it may be said to be above all other discoveries. For the worker who finds a new natural law of *action*, however great it may be, must temper his pride with the reflection that inevitably his law will in time be shown forth as but a part of some still greater one, incorporating his own: "After me cometh a builder. Tell him, I too have known." But the existence of an element is a fact of the universe; an element is a cosmic unit, superior to the accidents of place and time; it will outlast man who discovered it for himself; ironically enough for the chemist who finds it, it can even outlast chemistry and all that works by chemistry in Nature. It is this which justifies us in hailing Priestley and Scheele, Berzelius, Davy, Mosander, Bunsen, Rayleigh, Ramsay and Travers—and let us add Mme. Curie, Hevesy and Coster—together with the two score or so successful followers of their methods, as being privileged far beyond the ordinary; so also, of course, the discoverers of the electron and of the proton. To tell the full tale of any one of these investigators' work worthily, and while first-hand recollection is still there to be drawn upon, is to give us, and to leave to our scientific posterity, something to be grateful for.

What it is in Ramsay's discoveries which makes them conspicuous among the greatest work of this kind, needs little explanation now, when thirty years have given time for even those who were at first backward or hastily critical to be taught. Let those who have watched the unrolling of the scroll since 1893 pause to recall how they were first astounded by Rayleigh and Ramsay's finding something new in air—in air!—then by its being an element—an inert, monatomic element!—then by Ramsay's suddenly producing a quite new gaseous surprise out of quite another magical hat, the materialisation of a spectral line scarcely anyone had seen; and how then there came the period of suspense, while the chemical world talked or waited or went about its business, and Ramsay, and Travers with him, strove to push on into the new country that they believed in—and suddenly got there, with krypton, neon, and xenon. A whole unsuspected group! No other chemist has done it. Thereafter a well-earned increment to the group came with Rutherford's radium emanation; the weighing of emanation by Ramsay and Whytlaw Gray, the discovery by Ramsay and Soddy of the formation of helium from it, with Rutherford's precise identification of his α-rays with helium particles, all these rounded off one astonishing chapter and began another. Now, in this later chapter—would that Ramsay could have lived to see it—the newer generation of chemists and physicists familiarly use Ramsay's elements as fixed and indispensable bench-marks in the atomic surveying whereby Mendeléeff's atomic geography is seen to fall into one consistent frame; and factories bottle the gases in cylinders. Seen thus, the whole thing has only one parallel, and that is Priestley's discovery of oxygen, and its aftermath. The parallelism can be traced out quite closely; and the debt of the twentieth century to Ramsay in physical science is proving not less than that of the nineteenth to Priestley.

Accounts of the work on the inert gases have been issued before, as for example by Rayleigh as regards argon ("Scientific Papers," vol. 4, 188-201), and in his son's "Life of Lord Rayleigh"; by Ramsay ("Gases of the Atmosphere," 3rd edit., 148-269), and by Tilden in his "Life" of Ramsay (1918). For this reason it is natural that some of what Dr. Travers tells in the present volume is broadly familiar; but there is much that will be new, and greatly welcome, to its readers. For a story of classical discoveries cannot ever be told

to our full satisfaction by their originator, because he either does not realise or else cannot in modesty tell his own traits and behaviour in action, upon which his success so largely depends; and the trivial, yet to us interesting, personal incidents of the work are to him irrelevant. Even his familiar letters miss out much that we can only guess at; whilst a later biographer, however sympathetic, can rarely be as circumstantial as we should like; of strategy we read little, of tactics a good deal, and of behaviour under fire only rarely. Here, however, is an account at first hand from one who was a brilliant and essential junior partner in all but the very first part of Ramsay's work on the rare gases; and it is based upon Ramsay's own MS. papers and laboratory notes, handed over to Dr. Travers by Lady Ramsay and Mrs. Tidy with an invitation to arrange them. Dr. Travers has brought all his own enthusiasm to renew that which created his material. Consequently, the spirit of the account as a whole, and the numerous circumstances that are recaptured, reveal to the reader more vividly than any other written word the indomitable artillery of Ramsay's opening attack on a problem, and the flashing élan with which he launched his full force into the breach to carry the citadel.

The genesis of Lord Rayleigh's fundamental work on gaseous densities, out of which came his own and Ramsay's discovery of argon, lay in his plan, formed in 1882, to test Prout's hypothesis. Dr. Travers dwells instructively and at length upon this point, which has also been mentioned by Ramsay himself (loc. cit.) and by Tilden in his "Life." (It is curious that both for Cavendish and for Rayleigh it was the same element—nitrogen—which began by being a nuisance and was in each case turned, under masterly hands, into a source of rich knowledge.) Dr. Travers, in treating of the ensuing joint researches (four chapters are devoted to argon), says:

"Lord Rayleigh and Ramsay stand out from amongst their contemporaries, chemists and physicists, as the two men who alone realised the significance of the apparent discrepancy in the densities of nitrogen. They were also the two men who alone were capable of developing the discovery. In genius, method, and temperament each was in many respects the opposite and the complement of the other. No modern discovery ever awakened more interest than the discovery of argon; never did scientific men receive more gratuitous advice or criticism; but never was advice or criticism more completely sterile."

Ramsay, on his part, brought to the problem, besides his own qualities, a technique in glass-blowing and in the handling of gases which all his Bristol and London work had fostered (and at that time there were very few glass-blowing chemists); and he brought a repertoire which included an unsurpassed wealth of chemical fact and a great deal of quite recent physics. For example, he tried magnesium as the absorbent for nitrogen because, as he tells us (loc. cit., 158), he had noticed its property several years before while trying to synthesise ammonia in the presence of various heated metals. The property was not at all common knowledge among chemists. Again, the idea that the ratio of the specific heats of a gas gives a clue to its molecular complexity must have been little known to the average chemist, and Dr. Travers shows how it was doubted by many physicists; yet Ramsay was not merely aware of the idea, but had actually applied it experimentally in studying some organic compounds; so he was able at once to turn to it—the only possible test—to try the complexity of the argon molecule. As Lord Rayleigh pointed out, it was only when that had been done that they allowed themselves to utter a word suggesting that argon was an element.

Arising out of the last-mentioned measurements, Dr. Travers tells us that Ramsay did the whole of them, including controls, between Monday morning and Friday evening; and he adds the significant remark: "That work carried out in this manner could be so highly productive was due to Ramsay's insight into the essentials of a chemical problem, and his judgement as to the degree of experimental accuracy required in order to furnish adequate proof of the particular hypothesis which he was investigating." With this we may link another quotation given from Rayleigh and Ramsay's Royal Society paper: "Although the evidence of the existence of argon in the atmosphere . . . appeared overwhelming, we have thought it undesirable to shrink from any labour that would tend to complete its verification." These principles permeate the whole subject of Dr. Travers's book.

As all who have been privileged to be with Ramsay know—and let me add, what Dr. Travers could not, that the following remark applies to him also—the speed with which he arranged experiments and made them go was extraordinary. From the start of his share of the work leading to argon, it took him a month to obtain "the gas which I think I have got" (written to Rayleigh); and about another month to isolate it in bulk and

find its density (August 1894). For speed, however, the discovery of helium in March 1895 would be hard to match; for it took a fortnight. Was ever 3*s*. 6*d*. better spent? Incidentally, we are reminded by Ramsay's MS. notes (here generously reproduced in facsimile) that helium was provisionally christened "krypton" until Crookes's telegram came: "Crypton is helium 58749. Come and see it."—"Went and saw it," is Ramsay's laconic addition to his MS. copy. This chapter (v.) will be found very interesting.

The ensuing three years are covered in as many chapters, and with Chap. ix. (May and June 1898), where Dr. Travers's own memories of all the comings and goings are at their keenest, we reach the best of the twelve in the book. Ramsay and Travers's irresistible pinning-down of krypton and xenon at their very first handling of liquid air, and the unforgettable moment when neon blazed into their ken, are made the culminating point of a dramatic and yet matter-of-fact story, the end of which is rightly drawn at the close of Travers's work with Ramsay.

The frontispiece, diagrams, and the ample facsimiles of MSS. are happily chosen and are well reproduced. By some strange oversight, nearly all the dates in the text are wrong, but as the error is either one decade or two, it jerks us into the wrong century and the intention is obvious. A few other slips in writing (for example, p. 67) will doubtless be put right for later issues. The format and type work are dignified, as the book deserves.

All who worked with Ramsay, very many who did not, and every young student of chemistry or of physics, should read this book; they will gain great pleasure and new inspiration. For, as Dr. Travers writes of Ramsay, and finely exhibits in this volume, "He was a great friend, a great leader, and a great man."

IRVINE MASSON.

Timber Exploitation.

Manual of Forest Engineering and Extraction. By J. F. Stewart. Pp. xv + 188 + 100 plates. (London: Chapman and Hall, Ltd., 1927.) 15*s*. net.

MR. STEWART'S book has been written primarily for forest students, but it should also be useful to those engaged in timber exploitation in many parts of the world. The subject dealt with is a very wide one, covering as it does the preparation of streams for floating, river surveys, the felling and clearing of areas, logging operations, including the construction and use of wire ropeways, slides, chutes, inclined tramways, the construction of forest roads and bridging, the building of all classes of forest rest houses, sawmills, and finally extraction work in Indian forests. It would be possible to write a volume on any one of these subjects, and therefore the author has had of necessity to deal with each subject somewhat briefly. His personal experience of forest engineering in many parts of the world, and especially in Canada and Africa, has enabled him to bring out clearly the important points requiring special attention by young forest engineers confronted with the everyday problems they have to solve, in those forests of the Empire which at present are not under intensive working. Much sound advice is given on camping in unhealthy forests, on the choice of camping grounds, and precautions necessary when camping in both temperate and tropical climates. A small omission is made when dealing with methods of transport in India, as no mention is made of the bullock-cart, while the elephant is omitted as a drag-animal in the chapter dealing with felling and clearing forests, though mentioned in the last chapter.

Surveying, clearing streams, and log transport is briefly dealt with, though the reader may feel the need of diagrams to enable him to picture clearly in his mind the different types of skids and sledges in use. Wire ropeways are dealt with in some detail, and necessarily so, as they form an important means of exploiting logs in such areas where extensive concentrated fellings are undertaken, as is the case in Canada and the United States of America.

The chapters dealing with slides, chutes, inclined tramways, roads, and trestle bridges are perhaps the most instructive and useful. The types of each class are dealt with lucidly and clearly, the subject matter being sufficiently well illustrated by photographs and diagrams to enable a forest engineer to select and construct the type most suited to the individual extraction problem before him. Considerable space is given to forest railways and water transport, based chiefly on work in Canadian and North American forests; the value of these chapters, and especially that on floating, would have been enhanced by descriptions and illustrations of similar work in other parts of the world. "Permanent Buildings" is perhaps not a quite correct heading for Chapter xi., which also deals extensively with grass huts and similar temporary erections as used in central Africa; this in no way detracts from the value of the subject matter. The work ends with a brief chapter on forest operations

in India. The author describes camping as luxurious, which is undoubtedly the case in certain provinces, but very much the reverse in others.

The subject as dealt with clearly denotes Mr. Stewart's wide practical experience, as the information that matters when having to carry out work of this character in the forest is dealt with in such a manner as will assist the young engineer; this being so, it is the information necessary to impart to the student. The illustrations are profuse and good, making with the subject matter a valuable addition to the literature on forest engineering and extraction.

Modern Physics.

Introduction to Modern Physics. By Prof. F. K. Richtmyer. Pp. xv + 596. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1928.) 25*s*. net.

THERE is a distinct tendency in recent American text-books for the authors to expound the subject matter of physics as if their books were intended to appeal to readers whose professional interests are not very closely allied to their progress in physics. Prof. Richtmyer's book may show some traces of this tendency, but it is undoubtedly intended for readers who are keenly interested in modern physics, although his delightfully clear introduction to the subject will certainly introduce him to a very wide circle of readers. In fact, his book is one of the most valuable of the contributions to the literature of physics which American writers have made.

Although the work is termed an introduction to modern physics, it is more strictly speaking an introduction to modern physical theories, and the author has selected for examination some of the more important classical concepts as well as the modern concepts of physics, in order to give his readers a correct perspective of the growth and the more recent development of the subject as a whole. He has consequently omitted a description of certain important branches of modern physics, such as thermionic phenomena, from his work, and has only briefly mentioned certain other important branches, such as the conduction of electricity through gases. Yet his very sound and thorough exposition of the chosen branches is undoubtedly of much greater value to us than any skeleton key or guide to the study of modern physics could possibly be, and he is able to achieve the desired object of outlining the origin, development, and present state of those two mighty, outstanding problems of modern physics, the reconciliation of the quantum and wave theories of light and the structure of matter. It is, however, a matter of regret that he has not taken the opportunity to present us with a simple outline of the conceptions recently introduced by wave mechanics.

Prof. Richtmyer opens with a historical sketch, dividing the history of physics into four periods, namely, the period from earliest times to A.D. 1550, in which experiment was absent; the period from A.D. 1550 to 1800, in which experimental methods of scientific inquiry were established; the period A.D. 1800 to 1890, in which those portions of physics which we term classical physics were developed; and lastly, the period dating from the discovery of the photoelectric effect in 1887 to the present day. There is nothing particularly exciting or original about this historical sketch; it is merely a very useful form of introduction which finds a definite place in a book of this type. The author then devotes a chapter to the electromagnetic theory of light, in which Maxwell's equations are developed, and it is shown that the theory requires that an accelerated electric charge should always radiate energy, the wave front being continuous. Then follows a chapter on the theorems concerning the radiation from moving charges. The fifth chapter deals with the photoelectric effect, and is noteworthy for the clear way in which the possible explanations of the effect are discussed, the author indicating the difficulties confronting the wave theory and pointing out that, all the same, we have to rely on the wave theory to give us the energy value of a quantum.

The study of black body radiation and the origin of the quantum theory is excellently outlined in the sixth chapter, which is followed by a discussion of the quantum theory of specific heats, wherein Debye's theory is described at length and the reader referred to other works for the theories of Born and Kármán, etc. Incidentally, detailed references to special treatises and original papers are lavishly distributed in footnotes throughout the book. The ninth chapter, on series in line spectra, forms a very satisfactory introduction to the subject. The notation given by Fowler is used for the purposes of this preliminary discussion; but in the following chapter, on the nuclear atom and the origin of spectral lines, the notation of Russell and Saunders is adopted to deal with inner quantum numbers. These two chapters are likely to be much appreciated by students.

Some attention is devoted to the consideration of the static atom in the eleventh chapter, preceding a

discussion of the problem of the distribution of electrons in atomic orbits and the spectroscopic method of solution of the problem. The twelfth chapter is a very fine and up-to-date survey of our knowledge concerning X-rays. Finally, in the last chapter the problems of the nucleus are briefly reviewed, and here, in order to appreciate the care with which the book has been written, the reader may be recommended to consider the simple diagram of the magnetic deflection of α-, β-, and γ-rays and to compare it with the diagrams given in other textbooks. Among the appendices is a table showing the distribution of electrons in atomic orbits, according to Foote, and a table of important physical constants, and an efficient index is provided.

The book is excellently printed and illustrated, and Prof. Richtmyer is to be congratulated upon the appearance of a useful work which may be confidently recommended to teacher and student alike. L. F. B.

British Myrmecophilous Insects.

The Guests of British Ants: their Habits and Life-Histories. By H. St. J. K. Donisthorpe. Pp. xxiii + 244 + 16 plates. (London: George Routledge and Sons, Ltd., 1927.) 18*s.* net.

ONE of the most interesting and remarkable features of the biology of social insects is betrayed in the relationships they maintain with other animals living in association with them. A very large number of the latter creatures are myrmecophiles or ant guests and the majority of them are insects. Although British ants number only 35 species, many times that number of myrmecophiles are known to live in a more or less definite biological relationship with them. In some cases they are extranidal, or in other words, the ants seek out their myrmecophiles, while in others they are intranidal, the ants being passive and are sought out by their guests. Mr. Donisthorpe's enthusiasm and energy have enabled him to add 146 species to the myrmecophilous fauna of Great Britain, of which no less than 70 were new to science at the time of their discovery. His intimate knowledge of this subject has enabled him to produce a book that will long remain a standard work.

The volume is arranged so that each order or group of myrmecophiles is dealt with in a chapter of its own. The Coleoptera are by far the most numerous in point of species and, since they are a favourite order with the author, are discussed at length. Five British species are true guests or symphiles, which are tended and often fed and licked by their ant hosts. The largest number, however, are synoeketes or forms which are indifferently tolerated within the nest: they are represented by members of nine families of beetles, the majority being Staphylinidæ. A small number of species of the latter family are synechthrans, which are hostile in behaviour, forcing themselves on their hosts and usually devouring them or their offspring.

In the chapter on Hymenoptera the relations which ants exhibit with members of their own or of different species are discussed, while the various kinds of Parasitica found within the confines of the nests are enumerated. We know less concerning these than almost any other group of myrmecophiles: some are unquestionably parasitic upon ants, a larger number probably parasitise various other myrmecophiles, but with regard to the majority, little beyond conjectural remarks can be made, and they offer a promising field for exploration by a skilled observer.

In the short but interesting chapter on Lepidoptera, five species of moths are regarded as synoeketes which live within the nest in the rôle of scavengers. The relations between ants and certain Lycænid caterpillars are largely extranidal, the ants seeking out such larvæ wherever they are feeding in order to imbibe their glandular secretions. In the case of *Lycæna arion*, the larva, when in its fourth instar, is carried by ants into the nest, notwithstanding the fact that it lives at the expense of their own larvæ. Other chapters are concerned with Diptera, Hemiptera (three chapters), Acarina, Isopoda, etc., and the book concludes with a bibliography and both authors and species indexes. A. D. IMMS.

Our Bookshelf.

(1) *Comparative Physiology of the Heart.* By Prof. A. J. Clark. (Cambridge Comparative Physiology Series.) Pp. vi + 157. 8*s.* 6*d.* net.
(2) *The Comparative Physiology of Internal Secretion.* By Prof. Lancelot T. Hogben. (Cambridge Comparative Physiology Series.) Pp. vii + 148. 10*s.* 6*d.* net.
(3) *Ciliary Movement.* By J. Gray. (Cambridge Comparative Physiology Series.) Pp. viii + 162. 10*s.* 6*d.* net.
(Cambridge: At the University Press, 1927 and 1928.)

HUMAN physiology will ever continue to be the science which will pre-eminently fascinate the mind of man in virtue of the directness and personal character of its appeal. The versatility of man, which has placed less resourceful creatures under his dominion, has also led to the combination of so many physiological processes in a single species that it is not surprising that several of these processes,

considered individually, may be found more highly developed in lower species. For the better understanding and for the more thorough investigation of such living processes, recourse must be had to animals in which the particular mechanism under consideration is most highly typified. It is just here that the Cambridge series of Monographs on Comparative Physiology brings the student or worker in physiology into touch with the evolution, the variety, and what might perhaps be regarded by him as the exaggeration of normal human processes.

(1) The heart is the organ which has always attracted the attention of human beings from the remotest ages, and it is fitting that a volume should be devoted to this organ, giving in this case some qualitative and many quantitative characteristics of species differing widely in their normal activities.

(2) The discovery of internal secretions is so recent and so largely based on a study of the higher vertebrates, that a volume putting forward the present state of knowledge regarding the invertebrates as well is useful not only in making possible wider generalisations, but also in providing new material of a simpler type for further investigation.

(3) The volume on ciliary movement deals with a subject which, in virtue of its complete overshadowing by muscular movement, is only very briefly referred to in text-books on human physiology; its study is best carried out in those organisms depending wholly on ciliary movement for locomotion, muscular movement being non-existent; only in this way can the various hydrodynamical problems be investigated.

All three volumes present the matter in a readable manner with well-chosen diagrams, and will prove of interest to the student of general physiology as well as to the physiological investigator.

(1) *In the Beginning: the Origin of Civilisation.* By Prof. G. Elliot Smith. (The Beginning of Things Series.) Pp. vi + 90. (London: Gerald Howe, Ltd., 1928.) 2*s*. 6*d*. net

(2) *The Origins of Agriculture.* By Harold Peake. (Benn's Sixpenny Library, No. 6.) Pp. 78. (London: Ernest Benn, Ltd., 1928.) 6*d*.

(1) PROF. ELLIOT SMITH's little book, though not the first in order of publication, is the introductory volume in the series "The Beginning of Things." In his prefatory remarks he explains that the object of the series is the publication of a number of volumes, each dealing with some aspect of culture from a common point of view. What this point of view is, it is the purpose of the introductory volume to demonstrate.

Here we have Prof. Elliot Smith at his best. So far as the theoretical side goes, he has given us no more lucid and logically argued statement of the case for his views on the diffusion of culture and its origin in Egypt. Although he is careful to point out that the pursuit of any single line of investigation such as the origin of agriculture or of metal working leads to disaster, virtually his case rests upon the first cultivation of barley in Egypt.

(2) Mr. Peake, in his brilliant little study of the origin of agriculture, of which the size and the popular form of publication are no criterion of the importance, is directly at odds with Prof. Elliot Smith. He has collected carefully all the evidence bearing upon the origin of the different kinds of grain. After a judicial survey, his conclusion is on the whole against Egypt and turns rather to northern Syria. Apart from this question, Mr. Peake's book gives an admirably reasoned account of the prehistoric conditions of life in which agriculture must have originated.

Where are the Dead? Pp. ix + 136 + xi. (London, Toronto, Melbourne and Sydney: Cassell and Co., Ltd., 1928.) 3*s*. 6*d*. net.

THIS volume comprises a collection of articles by a wide variety of writers upon the subject of human immortality, contributed to the *Daily News*. Undoubtedly the most interesting of these to students of science will be the contributions of Sir Arthur Keith and Prof. Julian Huxley, since these contain a concise and clear statement of views widely held in scientific circles. It is probable that the importance for religion of either positive or negative views on this subject has been exaggerated.

Sir Arthur Keith rightly says that "If the spirit of truth is the kernel of religion, then men of science are truly religious beings." He might have added that absorption in disinterested research is one of the modern spiritual equivalents for religious asceticism. At the same time, students of science should not overlook the significance of a point of view such as that expressed with great ability in the contribution by Mr. Hugh Walpole, which strikes us as in some ways the best thing in the book. Whilst the others, orthodox and unorthodox alike, are all more or less obsessed with the distinction between body and mind (even when they reduce these to common terms), Mr. Walpole sees that the only important distinction is that between the elements in our experience which are exactly measurable, and those which are not. The important thing about man is not that he has, or has not, a 'soul,' but that "out of such a midget there have proceeded the spiritual greatness of Hamlet, the magnificence of the Fifth Symphony, the glorious simplicity of St. Francis. . . ." J. C. H.

Factors affecting the Distribution of Electrolytes, Water, and Gases in the Animal Body: Lectures delivered at Rutgers University under the Luther Laflin Kellogg Foundation. By Dr. Donald D. Van Slyke. (Monographs on Experimental Biology.) Pp. vii + 62. (Philadelphia and London: J. B. Lippincott Co., n.d.) 10*s*. 6*d*. net.

THE title of this little monograph may alarm those who are not gifted with a taste for mathematics, but its perusal leaves only a feeling of admiration for the manner in which the author has presented his subject. An examination of the degree to which the distribution of electrolytes, water, and gases in the body obeys the laws of physics and chemistry necessitates the use of a certain amount of mathematics, but the presentation is so clear

that even the average student should be able to follow it with ease. The subject matter forms a useful exposition of the way in which physico-chemical theory can be applied to the prediction of biological phenomena, as well as the necessity, in considering such phenomena, of using the methods of synthesis in addition to those of analysis, if a true idea of their influence upon each other in the living intact organism is to be attained. Among the subjects dealt with are the functions of hæmoglobin and the mechanisms of the production of œdema. A selected bibliography is appended. For its size, the price seems somewhat high; but the monograph is well worth reading by all interested in this subject.

Aspects actuels de la physiologie du Myocarde. (Première série.) *L'onde d'excitation motrice, son origine, sa propagation, ses manifestations électriques.* Par Prof. Henri Frédéricq. (Les problèmes biologiques, Tome 7.) Pp. viii + 300. (Paris: Les Presses universitaires de France, 1927.) n.p.

This is the seventh volume to appear in the collection of monographs on biological problems issued under the guidance of a technical committee comprising some of the best-known names in French biological science. The preceding volumes have, in the main, dealt with physico-chemical and embryological subjects, with the exception of Lapicque's important monograph on a subject which, like the volume under review, is more directly physiological. The author has collected together a considerable amount of data of a representative character and he has moulded it into an orderly review of the present state of knowledge with regard to these properties of the myocardium, while each chapter is rounded off with a useful summary. The book should make an appeal to students of physiology and also to medical practitioners, since the subject matter is concerned chiefly with the mammalian heart.

Macedonian Imperialism and the Hellenization of the East. By Prof. Pierre Jouguet. Translated by M. R. Dobie. (The History of Civilization Series.) Pp. xx + 440 + 7 plates + 4 maps. (London: Kegan Paul, Trench and Co., Ltd.; New York: Alfred Knopf, 1928.) 21*s.* net.

The keynote of this volume is the imposition of political unity on the "small collective individualities" of which the rise has been described in the earlier volumes of the Greek series, and the demonstration of how the common civilisation, which had hitherto been their bond, was affected by an external force which in its origin at least was alien to Hellenism. The hero of the epic, for it is nothing less, is necessarily Alexander, and of him Prof. Jouguet has made a truly epic figure. He sees in him intensity of character, power of imagination and thought, fortified by literature and philosophy. His qualities were accompanied by an extraordinary clearness of mind in carrying out his projects. The weaknesses of Alexander may lead one to question the true character of his idealism, but of his genius there can be no doubt. To this Prof. Jouguet does full justice, without attempting to disguise the flaws in his organisation, which led to the break-up of the Empire. In dealing with the later period, the author's very careful study of Egyptian conditions especially calls for commendation.

Raw Materials of Commerce. By J. Henry Vanstone, assisted by Specialist Contributors. Complete in about 24 Fortnightly Parts. Part 1. Pp. ii + 32. (London: Sir Isaac Pitman and Sons, Ltd., 1929.) 1*s.* 3*d.* net each part.

This work is planned to give accurate and modern information about the raw materials of industry. It is to be divided into four sections, covering vegetable, animal, mineral, and synthetic products respectively. The contents gives the impression of a comprehensive work which should be of considerable value to students of geography, economics, and commerce, as well as to persons actually engaged in manufactures. The first part, in addition to the introduction, has articles on fibres generally, cotton, flax, and jute. Each article describes the plant concerned, conditions of cultivation, harvesting, and the preparation and marketing of the fibre. The author has succeeded in combining accuracy with the avoidance of unduly technical language. Much of the matter is not otherwise readily accessible except in expensive works dealing with one or other industry, or is scattered in technical journals. The work is well illustrated by photographs, maps, and coloured plates.

Principles and Applications of Electro-Chemistry. By Prof. H. Jermain Creighton. Second edition, revised and enlarged. In 2 volumes. Vol. 1: *Principles.* Pp. xvi + 488. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1928.) 20*s.* net.

The first volume of Creighton and Fink's book on "The Principles and Applications of Electro-chemistry," dealing with principles, has reached a second edition before the second volume, dealing with applications, has appeared. The second edition includes new chapters on "The Activity of Strong Electrolytes" and on "Theories of Strong Electrolytes," but the author has postponed the drastic operation of making the rest of the volume conform to the theory of complete ionisation.

Lehrbuch der physikalischen Chemie. Von Prof. Dr. Karl Jellinek. Fünf Bände. Zweite, vollständig umgearbeitete Auflage. Band 2: *Die Lehre vom festen Aggregatzustand reiner Stoffe; Die Lehre von den verdünnten Lösungen.* Lieferung 5. Pp. 273-560. 24 gold marks. Lieferung 6. Pp. xiv + 559-924. 32 gold marks. Band 2 vollständig. 88 gold marks. (Stuttgart: Ferdinand Enke, 1928.)

The two sections now received complete the second volume of Prof. Jellinek's text-book, of which the first volume and the initial section of the second volume were recently noticed in these columns (Oct. 6, 1928, p. 523).

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Observations of Luminosity of the Night Sky.

WE have now observed the luminosity of the night sky for three years at the Commonwealth Solar Observatory, using photometers kindly supplied by Lord Rayleigh. These measure the absolute intensities of three regions of the spectrum—the red, a patch of green which includes the auroral line, and the blue.

If it is legitimate to assume that the transmission through the red filter is free from auroral radiation, or at least that the latter is not important compared with the amount of continuous radiation which passes through it, it is possible to devise a method for eliminating all, or at any rate the bulk, of the continuous radiation superimposed upon that which is localised in particular regions of the spectrum. For this purpose it is only necessary to observe the sunlit sky or the moon through the photometer when the incident light has been reduced in strength to the scale of night sky intensities; this must be done in such a way that its quality is unchanged. Corresponding readings are then made of the transmissions through the three filters over the range usually encountered; from these, graphs are drawn relating the green and blue readings with those made through the red filter.

We are thus enabled to find the amount of green radiation associated with the continuous spectrum for any observed red reading; we subtract it from the radiation observed through the green and blue filters, thus obtaining the green and blue transmissions presumably free from the background of white light. By confining our attention to nights free from haze, we hope to avoid trouble from selective scattering at the red and blue ends of the spectrum. For similar reasons we avoid times when the sun or moon is near the horizon. A considerable amount of green auroral radiation remains, and its fluctuations may be traced throughout the year. Maxima tend to occur in April–May and October–November. In 1926 the former, and in 1927 the latter, was the more pronounced. In the present year the April maximum was very marked, but the November readings now in progress are on some nights exceptionally large.

The true auroral blue component fluctuates in a somewhat similar way but with a smaller amplitude. It is probably absent altogether at certain seasons. There is high correlation between the blue and auroral green values about April and November, with low values at other times. Lord Rayleigh's suggested division of auroræ into two types, polar and non-polar, is supported; it is suggested that the occurrence of faint auroral illumination of the polar type is responsible for the high correlation in April and November, probably through the excitation of nitrogen bands. At other times of the year the auroral green radiation appears to be the sole characteristic of the non-polar type.

It seems likely that some considerable portion of the differences noted by Lord Rayleigh at different stations on the same night are due to the admixture of continuous spectrum. As the accompanying table shows, the elimination of the continuous spectrum usually reduces the differences considerably; the first five columns are reproduced from Lord Rayleigh's paper (*Proc. Roy. Soc.*, A, **119**, p. 23; 1928).

Date.	Place.	Observed.			Reduced.		Differences.				Remarks.
							Auroral.		Blue.		
		Red.	Auroral.	Blue.	Auroral A.	Blue B.	Observed.	Reduced.	Observed.	Reduced.	
Jan. 16, 1926	England	−4·4	−1·4	+5·8	2·6	1·7	3·4	0·8	3·2	0·8	Reduced values show improved agreement. (Canberra values, $A=3·3$, $B=2·8$, agree well with Cape.)
	Cape	−1·9	+2·0	+9·0	3·4	2·5					
Mar. 2, 1926	England	−3·6	−0·2	+6·4	3·0	1·5	2·2	−1·2	1·3	−1·8	Difference persists. (No Canberra readings, moon nearly full.)
	Cape	−0·4	+2·0	+7·7	1·9	−0·3					
April 15, 1926	England	−3·6	−0·8	+6·4	2·4	1·5	3·2	1·9	1·9	0·7	Outstanding auroral difference probably due to auroral display in S. latitudes. (Canberra reduced values, $A=4·0$, $B=2·3$, agree well with Cape.)
	Cape	−2·4	+2·4	+8·3	4·3	2·2					
Sept. 19, 1925	Shetland (Lerwick)	−4·4	−2·8	+3·4	1·2	−0·7	4·5	3·7	3·0	2·2	Differences persist. Lerwick's readings outside range of experience at Canberra.
	England (Northumberland)	−3·6	+1·7	+6·4	4·9	1·5					
June 7, 1926	Hawaii	−4·7	−0·9	+5·1	3·5	1·3	3·0	0·6	2·8	0·5	Reduced values show improved agreement.
	Canberra	−2·4	+2·1	+7·9	4·0	1·8					

As Lord Rayleigh selected these pairs to emphasise the contrast between readings at different stations, it is likely that the bulk of the readings will not differ by nearly such large amounts after reduction. We have assumed that the instruments used elsewhere possess precisely the same qualities as ours and have used our own graphs for their reduction, but it would be an improvement, of course, to determine the correction curves separately for each instrument, *in situ*.

The nature of the continuous spectrum is itself of interest. From the parallelism between the distribution of energy in the night sky and the sunlit sky or moonlight, we look at once for an explanation on the ground of the diffusion of sunlight or moonlight, though the rotundity of the earth makes this difficult to picture. At the same time, we cannot overlook the possibility that this faint white radiation may

arise from some new form of auroral excitation originating perhaps outside the earth's shadow, or to the recombination of ions which had previously been separated.

The annual period is pronounced, the maximum with us occurring in May or June of each year. This suggests its association with the phenomenon known as the 'Gegenschein,' because it is at this season of the year that the sun is most nearly opposite the place of observation.

On some nights the sky appears to be of great brilliance. The outstanding feature is the smallness of the transmission through the red filter. The auroral green radiation is then relatively bright, but not absolutely large. The main criterion for a brilliant sky is thus the absence of a continuous spectrum.

A memoir embodying the observations made at Mount Stromlo in 1926 and 1927, together with a detailed account of the method of reduction outlined above, is in the printer's hands and will shortly be available for distribution. W. G. DUFFIELD.

Commonwealth Solar Observatory,
Mount Stromlo, Canberra,
Australia, Nov. 11.

The Electromagnetic Equations in the Quantum Theory.

IN spite of the great progress made in recent years, the theory of radiation is still in rather an unsatisfactory state. By the methods of Schrodinger it is possible to express the radiation of atoms in the form of electromagnetic waves, but the formulation is quite incomplete, because it fails to give the reaction of the radiation on the emitting system. The theory of Dirac (*Proc. Roy. Soc.*, **114**, p. 243) is free from this cardinal fault, but fails to show the relation of radiation to static electric force; it is in fact a valid theory of light, but scarcely an electromagnetic theory. It is of course quite probable that in a complete theory there is no need, or room, for radiation at all, in that the direct interactions of particles according to relativity principles will give all that is required; but radiation must always remain a convenient eliminant, expressive of the effect of a number of particles on a distant one. So it seems not out of place to fit the electromagnetic equations into the general scheme; if they are wrong, it is still interesting to know why Maxwell made the mistake of inventing them !

The following considerations suggest in a natural way how the equations arise. Although by Schrödinger's method it is possible to calculate the radiation scattered in the Compton effect, yet the method is incompetent even to express the idea embodied in the celebrated experiment of Geiger and Bothe (*Zeit. für Phys.*, **32**, p. 639), in which it was observed that the directions of scattering of electron and light quantum were absolutely correlated. The simplest way of making it possible to express such an idea is to endow the light with a set of co-ordinates X, Y, Z, T, and to have a wave function simultaneously involving both these and the x, y, z, t of the electron. Some such idea is also directly suggested by Dirac's theory, though he makes no use of actual co-ordinates.

The equation determining the behaviour of an electron in a field of radiation is, according to Dirac (*Proc. Roy. Soc.*, **117**, p. 610),

$$(p_0 + \alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 p_3 + \alpha_4 mc)\psi = 0.$$

Here the α's are certain four-rowed matrices, and p_1 stands for $\frac{h}{2\pi i}\frac{\partial}{\partial x} + \frac{e}{c}V_1$, where V_1 is the first component of vector potential, while similar meanings connect p_2, p_3, p_0 with y, z, t. Now $\frac{h}{2\pi i}\frac{\partial}{\partial x}$ is symbolically the momentum of the electron, and it is therefore natural to regard $eV_1 c$ as the momentum of the radiation. The equation then expresses the constancy of momentum in the interaction, and this is just what is used in working out the Compton effect by elementary principles. It is only a step to replace $eV_1 c$ by $\frac{h}{2\pi i}\frac{\partial}{\partial X}$ as the symbolic momentum of the radiation. If now we have a field of radiation far away from the electron, the solution must split into two independent factors, and the radiation by itself will satisfy the equation

$$\left(-\frac{1}{c}\frac{\partial}{\partial T} + \alpha_1\frac{\partial}{\partial X} - \alpha_2\frac{\partial}{\partial Y} - \alpha_3\frac{\partial}{\partial Z}\right)\psi = 0.$$

When the values of the matrices are substituted, this equation is replaced by four which are exactly Maxwell's equations for free space, combined according to the rules :

$$\psi_1 = -iH_z,\ \psi_2 = H_y - iH_x,\ \psi_3 = E_z,\ \psi_4 = E_x + iE_y.$$

The only difference is that E and H must be real, whereas the ψ's are usually complex. In a recent paper (*Proc. Roy. Soc.*, **120**, p. 621), I pointed out this similarity, but at the time was unable to explain it.

This is, of course, only the germ of the matter, and it leaves many difficulties unsolved. Thus it will be immediately asked how the potentials V, which started as coefficients multiplying ψ, can be derived from part of the solution for ψ itself. The only answer that can be given is that the same sort of change occurs in other parts of the wave theory, when the reaction on a perturbing system is neglected. It will certainly be necessary to replace the term mc by some function of the co-ordinates, and, among other things, this should lead to an analogue to the classical calculation of electromagnetic mass ; but to carry the matter further raises a very fundamental difficulty which I cannot overcome. We have not only two superposed *spaces*, but also two superposed *times*, and this is an idea that is very difficult to apprehend, for it, so to speak, dislocates the whole process. This difficulty is not special to the present work, but inevitably occurs in any relativistic representation of more than one particle. Since it may be some time (or should it now be *times* !) before this trouble is overcome, I have been emboldened to write the present communication, showing the outline of how we may hope that the old waves can be fitted, almost without change, into the new scheme. C. G. DARWIN.

The University, Edinburgh,
Jan. 17.

The Absorption of X-Rays.

THE atomic X-ray absorption coefficients of the elements have commonly been represented by simple formulæ of the type $\tau_a = kZ^x\lambda^y$ (k a factor involving fundamental atomic constants, Z the atomic number of the absorbing element, λ the wave-length of the X-rays, x and y exponents not very different from 4 and 3 respectively). These formulæ have been derived in a variety of ways (J. J. Thomson, A. H. Compton, L. de Broglie, H. A. Kramers), and the complete expression for the absorption coefficient of an element over all ranges or X-ray wave-lengths has been represented as the sum of a number of such terms—each term corresponding to the fluorescent excitation of a distinct series or sub-series (K, L_1, ...), and dropping out for wave-lengths longer than that of the corresponding absorption edge. Experimental determinations of the absorption coefficients have shown fair agreement with theory, both with respect to the general run of the coefficients on each side of a discontinuity, and to the magnitudes of the discontinuities.

In spite of this approximate agreement, it has become increasingly clear that the simplicity of the formulæ in no way reflects a corresponding simplicity in the absorption process. There is very complete evidence (Robinson, Skinner) that the 'partial' absorptions of the individual electronic groups and sub-groups vary with λ in a much more complicated manner than is suggested either by the older absorption theories or by the measurements. The close adherence of the measured absorption coefficients, over wide ranges of wave-length, to the 'λ^3 rule' (Richtmyer's precision measurements)—or to the similar rules with slightly different exponents, favoured by Allen and others—must therefore be regarded as a statistical effect, due to mutually compensating variations in the partial absorptions.

Most of the available data have been fully discussed (notably by Richtmyer and Compton) in relation to the older absorption theories. Newer theories (Wentzel, Oppenheimer) lead to more complicated formulæ, which allow for the above-mentioned deviations of the partial absorptions from the λ^3 rule. Unfortunately, these formulæ cannot yet be implemented in a sufficiently precise numerical sense, and further experimental data are urgently needed.

It may perhaps be stressed here that the direct measurement of absorption coefficients can contribute relatively little evidence to some of the points at issue. The contributions of (say) the L electrons to the total absorption for wave-lengths shorter than that of the K discontinuity can, it is true, be deduced from the absorption curves, but only by the most intrepid extrapolation; and although the measurements have been conducted with the utmost skill by a number of workers, there remain some obvious and (Bothe) other less obvious difficulties of interpretation, linked with uncertainties in the allowance to be made for the effects of scattering.

It has long been realised that the 'magnetic spectrometry' of the secondary cathode rays from the absorber can provide valuable evidence, supplementary to that of the absorption measurements. The method is particularly suitable for comparing (say) the absorptions of the L electrons of a heavy atom and the K electrons of a lighter atom—the atoms being so selected that the secondary electrons emerge with similar energies in the two cases (allowing only a sufficient difference for the clear resolution of the two sets).

We are now carrying out experiments on these lines. With absorbers compounded or mixed with the two elements in suitable proportions, a single experiment is often sufficient to fix approximately the relative absorptions of the two sets of levels in question. We find, for example, that the two K electrons of a zinc atom absorb probably more—and almost certainly not less—X-radiation of wave-length 0·56 A. than the eight L electrons of tungsten.

According to one empirical absorption law, the tungsten L electrons should absorb 4·8 times as strongly as the zinc K electrons. According to de Broglie's theory, which (Richtmyer) gives in many respects excellent agreement with the measurements, this ratio should be 5·2. An extension of Kramers' theory, which attaches diminished weights to electrons in 'orbits' of higher quantum numbers, partially, but insufficiently, reduces the discrepancy. On the other hand, Kramers' theory fits many of the direct absorption measurements less well than that of de Broglie. In any case, all theories so far proposed contain necessary simplifying assumptions which could account for deviations of the kind observed, and it would be unprofitable further to discuss them here.

The purpose of this note is simply to point out some of the difficulties of the problem, and to indicate the nature of some of the points on which we hope to bring more detailed information. The method of corpuscular spectrometry, while limited in some of its applications, is unusually flexible in other directions. This flexibility imposes an obligation to extend the measurements over a wide range of X-ray levels, and with a wide range of primary radiations—especially in certain important regions. The preliminary stages of the work have been unduly protracted by exceptional local conditions, but we now hope to proceed comparatively rapidly with the full programme—although at best the investigation will be a lengthy one.

The work has been assisted by a grant to one of us (H. R. R.) from the Government Grant Committee of the Royal Society, for which we here desire to make acknowledgment.

H. R. ROBINSON.
C. L. YOUNG.

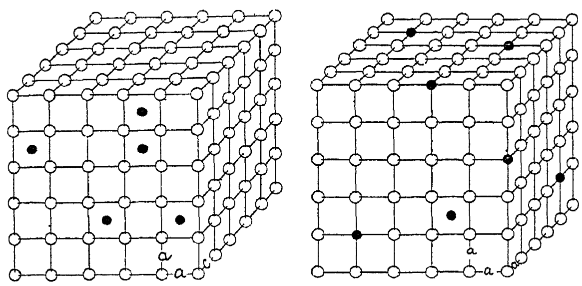
University College,
Cardiff, Jan. 10.

The Nature of Martensite.

DURING the past few years several papers have been published on the nature of changes in carbon steel during the processes of quenching and tempering.

The dilatometric investigations of Haneman and Traeger[1] have shown that during the process of tempering of quenched steel there exist three transition points: 100°, 235°, and 300°. The X-ray study has shown that tetragonal martensite disappears at 100° C. The second transition point (235°) on the Haneman's and Traeger's curve, also confirmed by X-ray investigations, is the temperature of transformation of austenite. At 300°, iron carbide, Fe_3C, is formed.

According to Honda's theory, the first transition point (100°) is accounted for by the transformation



a b
FIG. 1.

of the tetragonal lattice of the martensite into a cubic one, and we think that the arrangement of the carbon atoms in these two forms of martensite is the following:—

In tetragonal martensite the positions of the carbon atoms are definite, and they are situated at the centres of those faces which are perpendicular to the tetragonal axe (see Fig. 1*a*).

In cubical martensite the positions of the carbon atoms are not fixed. Some of them replace the iron atoms in the lattice, and some are situated at the centres of the faces (Fig. 1*b*). Any assumption that all carbon atoms should be situated at the centres of the faces would give a density considerably higher than is obtained experimentally.

Kurdumow and Kaminsky[2] have shown that the ratio of the axes of the lattice of the tetragonal martensite increases with the increase of the carbon

[1] Haneman and Traeger. *St. und Eisen*, p. 1508; 1926.
[2] G. Kurdumoff and E. Kaminsky. NATURE, Sept. 29, 1928.

contents in steel. Honda and Sekito,[3] however, have obtained from their experiments that the value of this ratio is independent of the contents of carbon, and that the ratio is equal to 1·07.

This result of Honda and Sekito is contrary to the well-known fact of the diminution of volume change of quenched steel with decrease of carbon contents. From Honda and Sekito's data we can conclude that in quenched steel with carbon content 0·2 per cent, the volume of tetragonal elementary cell is 5 per cent larger than the volume of an elementary cell of α iron. This is entirely contradictory to results of Matsushita [4] and Birnbaum,[5] who investigated the changes of volume of steel with small contents of carbon during the process of tempering. Matsushita and Birnbaum were also unable to obtain a transition point near 100° for steels with carbon content 0·2 per cent.

Prof. Honda has kindly informed me by letter of certain details of his and Sekito's experiments. According to that letter "Sekito placed the specimen in a porcelain tube, one end closed, packed with charcoal powder, and heated it in an electric furnace." In such conditions, surface cementation might take place, and that would give equal values for the ratio of axes for tetragonal martensite in specimens of steel with different contents of carbon. In fact, the constant values for the ratio of axes obtained by Honda and Sekito probably mean that the content of carbon in the surface-layers was the same in all cases.

The broadening of the spectral lines in the case of martensite, Honda and Sekito explain by the presence of the carbon atoms in the lattice. The presence of a carbon atoms changes the dimensions of the cells which they occupy, and exerts an influence on the dimensions of the surrounding cells, giving an irregularity in the lattice.

We entirely agree that such irregularity of the lattice is very probable in the case of martensite.

Now Debye [6] has shown that the heat movements of atoms in the lattice produce a decrease in the intensity of the spectral lines. In martensite, therefore, in this solid solution, the irregularities in the positions of the solvent atoms produced by the solute atoms give a continuous variation of the lattice parameter, and therefore also cause only a decrease in the intensity of the spectral lines, but not the broadening of them.

N. SELJAKOW.

Leningrad,
Sosnowka 2,
Physico-Technical Laboratory.

[3] K. Honda and S. Sekito. *Sc. Rep. Tôhoku Imp. Univers.*, **17**.
[4] Matsushita. *Sc. Rep. Tôhoku Univ.* 7, 43-52; 1918.
[5] Birnbaum. *Archiv. fur Eisenhut*, Heft 1, Juli, 1928.
[6] P. Debye. *An. d. Physik*, **43**, p. 49; 1914.

Raman Effect in Gases.

SINCE the discovery of the Raman effect in scattered light, investigation has been extended to a large number of substances in the solid and liquid state. So far as I know, practically nothing has been done on gases, if we except an observation on ether vapour by Ramdas. Of course, the main difficulty in the case of gases consists in the extreme weakness of the scattered radiation.

Using a very luminous spectrograph (aperture of camera lens 1 : 2·7) I have obtained plates which show Raman spectra of different gases. The light source employed was a mercury arc, and the exposure time was 48 hours, using gases at atmospheric pressure. The length of the spectrum on the plate was 16 mm. from λ3650 to λ5461; wave-lengths were measured by comparison with a copper arc spectrum.

This research is being carried on, and will be extended to a larger number of gases, and, if possible, with a more dispersive apparatus. But the results already obtained with carbon monoxide and carbon dioxide are perhaps worth a short notice.

Carbon monoxide shows two Raman lines at about λλ4432, 4810. They correspond evidently to the same quantum transition, excited by both λ4046 and λ4358 of mercury; the differences in frequency between the Raman lines and the exciting lines are found to be respectively 2154 and 2156 cm.$^{-1}$ (the agreement being better than is to be expected with the dispersion used), and this corresponds to an infra-red absorption band at 4·64 μ. In fact, a double band, with the centre at 4·66 μ, has been found in the absorption spectrum of carbon monoxide, so that there can be scarcely any doubt about the origin of the observed Raman lines.

The behaviour of carbon dioxide is quite different. The infra-red absorption spectrum consists mainly of three bands (each of which has a structure, depending on rotation states) at 2·7, 4·25, and 14·7 μ. These are interpreted by C. Schaefer and Philipps as being the three fundamental oscillation frequencies of the triatomic molecule.

Now, in the Raman spectrum no lines were found corresponding to any of these absorption bands, though they would all have fallen in the region of spectrum photographed. I observed instead two doublets, at λλ4639, 4616 and λλ4289, 4268, excited respectively by λ4358 and λ4046. They correspond to transitions of 1284 and 1392 ($\pm$10) cm.$^{-1}$, which have not been observed in absorption even through very thick layers of the gas.

A rather surprising coincidence appears, however, if we calculate the differences in frequency between the two components of the double band at 2·7 μ and the band at 4·25 μ (which has a much smaller separation). We find the values 1279 and 1381 cm.$^{-1}$, which agree within the limits of experimental error with the two frequencies given above.

One example is not enough to prove that this coincidence has a physical meaning, but it is a remarkable fact anyhow that none of the strong absorption bands of carbon dioxide appear in Raman effect. Investigation extended to other substances will show if really, for some types of molecules, not the infra-red absorption frequencies themselves, but only their combinations, appear as a Raman shift in the scattered radiation.

F. RASETTI.

California Institute of Technology,
Pasadena.

An Apparently Anomalous Raman Effect in Water.

CARRELLI, Pringsheim, and Rosen (*Zeits. für Physik*, **51**, 511; 1928) have shown that the Raman scattering by water molecules yields only one modified frequency, corresponding to an infra-red band at 2·90μ. This modified frequency has, at first appearance, two anomalous aspects: (1) the modified 'line' is really a broad band of approximately 500 cm.$^{-1}$ width, in contrast to the sharpness of Raman lines produced by organic liquids; (2) no infra-red band corresponds exactly with the centre of the observed scattered band, the nearest one being the strong 3·0μ infra-red band.

I believe that the Raman spectrum of water is not anomalous in either respect. In 1927 (*Phil. Mag.*, **3**, 618; 1927) I presented an argument, based largely on an attempted correlation of the water bands below 3μ, in which it was pointed out that the strongest infra-red band, the one at 3μ, was probably double, being made up of an overtone of the 6·1μ band and a new fundamental. I tentatively assigned a wavelength value of 2·9μ to this fundamental, and believe

that it is this fundamental band which shows up in the Raman spectrum. The overtone of the $6{\cdot}1\mu$ band would not be expected to appear since its fundamental does not occur. This appearance in the Raman spectrum of one fundamental and the absence of a second is believed to occur analogously in the scattered spectrum of ammonia in water solution (Carrelli, Pringsheim, and Rosen, *loc. cit.*) and of organic liquids (Pringsheim and Rosen, *Zeits. für Physik*, **50**, 741 ; 1928).

Again, the comparatively great breadth of the scattered water band is, after all, quite consistent with the breadth of the infra-red bands of water. I have measured, for example, the width of the $1{\cdot}46\mu$ water band (probably the first overtone of the $2{\cdot}9\mu$ band with possible other bands superposed) and have found it to be 800 cm.$^{-1}$ wide. This is somewhat broader even than the $2{\cdot}9\mu$ band found in the Raman spectrum.

JOSEPH W. ELLIS.

University of California at Los Angeles.

A New Type of Alum.

THE close external crystallographic similarity between potassium sulphate and potassium beryllium fluoride, K_2BeF_4, has previously been pointed out by Fedorov and Barker. Both salts crystallise in the orthorhombic system, and are pseudo-hexagonal. Adopting standard orientation, the respective axial elements are: For K_2SO_4, $a : b : c = 0{\cdot}7418 : 1 : 0{\cdot}5727$, and for K_2BeF_4, $a : b : c = 0{\cdot}7395 : 1 : 0{\cdot}5708$. It has further been suggested that, since the salts exhibited some structural analogies as indicated by the formulæ, this external similarity might be accompanied by true physical isomorphism. (The well-established isomorphism in the exactly analogous series $NaNO_3$ - calcite and $KBF_4 - KClO_4 - BaSO_4$ is of interest in this connexion.)

Further definite evidence with regard to this question has now been obtained. On allowing an aqueous solution containing equimolecular quantities of potassium beryllium fluoride and aluminium sulphate to crystallise at the ordinary temperature, it was found that crystals of the composition $K_2BeF_4 . Al_2(SO_4)_3 . 24H_2O$ were deposited. This salt crystallises in the cubic system, normally as octahedra, and is a true alum. It readily forms true overgrowths on the common alums, for example, chrome alum. A similar alum is obtained when potassium zincochloride, K_2ZnCl_4, is substituted for K_2BeF_4. The existence of these alums shows clearly that potassium sulphate and potassium beryllium fluoride are truly isomorphous.

Rubidium beryllium fluoride, Rb_2BeF_4, forms crystals which are isomorphous with those of the potassium salt. Pseudo-hexagonal interpenetration triplets are frequently formed as thin flakes. In these triplets the individuals are tabular on $a(100)$, the flakes being bounded by the form $q(011)$. In many cases the form $q(011)$ is absent, and is replaced by the form $o(111)$, bevelling the flake edges. The double refraction is weak and positive. The optic axial plane is $b(010)$, the acute bisectrix being the a-axis. Exactly analogous interpenetration is characteristic of potassium sulphate, and hence this triplet formation is significant. In the case of potassium sulphate, where the accurate measurements of Tutton are available, the twinning is described as taking place on a plane perpendicular, not to the actual $q(011)$ face, but to an idealised $q(011)$ face corresponding to a true hexagonal structure, *i.e.* twinning occurs as if the angle $011 : 0\bar{1}1$ were accurately, not approximately, $60°$.

W. R. C. CURJEL.

6 Ipswich Road,
Woodbridge, Suffolk.

The Methodology of the Inexact Sciences.

THE reply to my letter under the above heading (NATURE, Jan. 26, p. 130) rather misses my point. I was not discussing those points of contact between Mithraism and Christianity for which there is historic evidence, such as the ideas which Tertullian accused the former of borrowing from the latter. My contention was that in the particular example which I quoted the evidence was based on the fallacy—let us call it 'philonism'—which consists in attributing undue significance to the analogies or parallels that can be drawn between every two groups of ideas.

I have made the alarming discovery that you, Sir, the editor of NATURE, are simply a mythical survival of Mithraic beliefs. We have been accustomed to regard you as the champion of the light of science which is to prevail over the darkness of error and superstition, but this popular notion is clearly a survival of the legendary victory of Ormazd over Ahriman with which Sol Invictus Mithras was associated. The astrological notions which pervaded Mithraism survive in the attribution to you of pseudepigrapha dealing with astronomical subjects and the reformed calendar which we now enjoy, and also in the design at the head of the cover of NATURE. But perhaps the clearest evidence for my thesis is to be found in the prominent rôle assigned to you by common rumour in the orgiastic rite known as the Feeding of the Lions, an esoteric mystery which is practised during the meetings of the British Association. In this rite the spelæum of Mithras is represented by a room in a tavern, where the initiates consume with elaborate ceremony the flesh of a sacrificial bull. The dog which made possible the sacrifice of the bull by Mithras is here known as the 'jackal,' the sinister activity of the scorpion is imitated by the wagging of coat-tails, there are libations, and the torch-bearers common on Mithraic monuments are represented by the ceremonial burning of tobacco with which the orgy concludes.

At first I was unable to account for the title "The Red Lions" assumed by the initiates, and derived, according to popular tradition, from the public-house in which their first meeting was held. On referring to an authority, however, I find that "Lion" was the title assumed by devotees of Mithraism on reaching full initiation. It was not until he had passed through the degrees of Corax, Cryphius, and Miles that the initiate might attain to that of Leo, which entitled him to full participation in Mithraic mysteries. The crudeness of the popular story about the Red Lion public-house at Birmingham is thus only too apparent.

With this horrible example before me I do feel that the study of comparative religion ought to be purged of the philonistic fallacy. The other science in which that fallacy mainly occurs—namely, analytical psychology—is past praying for in the Mithraic or any other liturgy.

C. W. HUME.

14 The Hawthorns, Finchley, N.3.

Dr. J. W. L. Glaisher.

WILL you allow me to add a few points supplementary to the very full obituary notice of the late Dr. Glaisher, which appeared in NATURE of Jan. 26. One outstanding trait of his character was his extreme accuracy, which often made him undertake a journey to London to settle a minor historical or bibliographical point by referring to the actual books, when only quotations or copies of titles were available to him. His "Report on Mathematical Tables" (1873) perhaps best illustrates this characteristic. The Report is marvellously complete, and it would be very difficult to discover a mistake in it. Those who

have undertaken work of this kind will understand the difficulty of producing such a flawless work.

Besides pottery, Dr. Glaisher also collected arithmetical books of the fifteenth and sixteenth centuries, and his collection is probably the most complete one in private possession in Great Britain. Dr. Glaisher, however, was no mere book collector, but read all his books (whatever the language), and to good purpose, as his articles in the *Messenger of Mathematics* amply show. One of these, "On the Early History of the Signs + and −, and on the Early German Arithmeticians" (1921–22), will prove a mine of information to historians of mathematics, who cannot possibly read all the books themselves. Dr. Glaisher had a keen sense of humour, which enabled him to enjoy the human interest found even in such supposedly dry books, and he would often express his amusement of the vinous questions and problems abounding in the works of Adam Riese and Stifel. His collection of mathematical books, as he informed me, he bequeathed to the library of his college.

This did not exhaust Dr. Glaisher's activity as a collector. Two other collections he formed and prized, both very far afield from the realms of science, but characteristic as showing his varied human interests. One was of children's books with movable figures, and the other (a very complete one) of valentines. But whether these also were left to Trinity College, Cambridge, I do not know.

H. ZEITLINGER.

140 Strand, London, W.C.2.

Stellar Spectra in the Far Ultra-Violet.

IN a letter to NATURE of Nov. 24, 1928, Cario suggested that in the region of arctic winter-night the 3000 A. barrier of stellar spectroscopy may be absent, leaving a clear view down to 2100 A., where absorption by ordinary oxygen molecules sets in. To test this idea I have made a trip to Honningsvåg, in northern Norway, the expenses being borne by the Government Research Fund of 1919. Honningsvåg is a small fishing-village in the vicinity of the North Cape (lat. 71°, long. 26° E. approximately). At this place the sun is constantly below the horizon from Nov. 20 to Jan. 23. I stayed there from Dec. 5 to Dec. 11. Being primarily interested in large-scale variations in the atmospheric transmission, I brought only a rather crude equipment, consisting of a small objective single prism quartz spectrograph equatorially mounted on tripod, with a 3-in. guiding telescope fitted with a hand-driven gear. The length of the spectrum obtained by this instrument is about 8 mm. from 5000 A. to 3000 A., and the dispersion at 3000 A. about 100 A. to a millimetre.

The principal result of the trip is that Cario's conjecture has thus far not been confirmed. I photographed the spectra of several early type stars having relatively much radiation in the ultra-violet (α Lyræ, γ Cassiopeiæ, η Ursæ Majoris); but the spectra are cut off near 3000 A. in all cases. This result appears to vitiate the hope of penetrating beyond the 3000 A. barrier, at the same time as it may lend enhanced interest to the problem of atmospheric ozone. The equipment was insufficient to determine the height and thickness of the ozone layer, and it may be that Cario's idea is right in so far that ozone is no longer situated at the height of 50 km. found in lower latitudes. In this connexion it may be remarked that Honningsvåg is situated in the auroral belt, and from the auroral spectrum we infer that in this region free oxygen atoms will be present at a height of 100 km. and upwards. It is natural to infer that where monatomic and diatomic oxygen exist there will also be formed ozone, and that during the arctic night the ozone layer rises to greater heights than usual. It is hoped to look further into this problem on a later occasion.

SVEIN ROSSELAND.

Universitetets Observatorium, Oslo.

Zoological Nomenclature.

IN accordance with the provisions governing possible suspension of the rules, the undersigned has the honour to invite the attention of the zoological profession to the fact that application for suspension of the rules has been made in the case of *Nycteribia* Latreille, 1796, monotype *Pediculus vespertilionis* Linn., 1758. The Commission is requested to set aside the monotype designated in 1796 and to validate *Nycteribia pedicularia* 1805 as type of *Nycteribia*. *Pediculus vespertilionis* Linn. was based on an acarine (described and figured by Frisch, 1728) which is now classified in *Spinturnix*. Latreille was dealing with an insect which he erroneously determined as *Pediculus vespertilionis*. Unless the rules are suspended, *Nycteribia* should be transferred from the Diptera to the Acarina and should supplant *Spinturnix*; this would cause extreme confusion and upset generic and supergeneric nomenclature which has been accepted without challenge for about a century.

A vote on the foregoing proposition will be delayed until about Jan. 1, 1930, in order to give zoologists interested in the case ample opportunity to express their opinions, *pro* or *con*, to the International Commission on Zoological Nomenclature.

C. W. STILES
(Secretary of Commission).

U.S. Public Health Service,
Washington, D.C.

Science and Life.

THE attitude taken by Mr. Aldous Huxley, as described by Major Church in NATURE of Jan. 5, p. 6, does not strike me as altogether novel. Was it not given—and I think with implicit condemnation—by Matthew Arnold in four unsurpassable lines of "The New Syrens":

"Hath your wisdom felt emotions?
Will it weep our burning tears?
Hath it drunk of our love-potions,
Crowning moments with the wealth of years?"

Arnold's 'wisdom' did not connote science: but psychologically the parallel is close. It is one of time's and heredity's ironies that Mr. Huxley is grandson of one of that band of scientific friends who, with their wives, sometimes resorted to the woods and read poetry aloud; and, if memory do not play me false, the great Huxley on one such occasion read "Denone." Those great scientists' wisdoms could and did feel emotions at any rate.

FRANK H. PERRYCOSTE.

Polperro, Cornwall. Jan. 13.

The Green Ray.

As seen from my house at St. Leonards, the sun sets at sea up to about this date, and behind the South Downs from now onwards. Only in the latter case have I been able occasionally to observe the greenishness of the last ray, and then indistinctly, owing no doubt to the habitual want of clearness of the atmosphere over the Downs at sunset. To-day the sun set behind the sloping face (as it appears from here) of Beachy Head. The ray was pure green.

T. S. DYMOND.

St. Leonards-on-Sea,
Sussex, Jan. 19.

Oyster Cultivation and Related Researches in the British Isles.

By Dr. J. H. ORTON.

A VERY small proportion of the oysters sold in the British Isles is taken directly from public grounds inshore or offshore. Natural offshore oyster beds become fished out soon after they are found, as a result of indiscriminate fishing, and inshore public beds suffer the same fate unless fishing is suitably restricted. The difficulties in enforcing culture on public grounds have led to the leasing of the chief oyster beds in Britain to private individuals or companies or corporate bodies. Thus the bulk of the oyster supply is produced by oyster cultivation of some kind.

The English native oyster (*Ostrea edulis*) is in its essential characters the same as the Dutch and the flat French oyster, therefore young Dutch and young flat French oysters may be laid down on English beds to grow and wax fat, and then be only recognisable as of foreign origin by an expert. Large numbers of the Portuguese oyster (*Ostrea angulata*) are now produced in France, and an increasing number is being imported into England and sold after remaining on English beds for one or more years. American oysters (*Ostrea virginica*) are also imported from Canada and America, and similarly relaid and sold after remaining on English beds for one or more years. Neither of these two latter species breeds naturally in any quantity in England. Thus oyster production in England is concentrated chiefly on *Ostrea edulis*.

In the British Isles, oyster cultivators fall into two chief groups, namely, one concerned in producing young oysters in great quantity and rearing them to an age of 2 to 4 years for sale to the other group, whose business it is to buy medium-sized oysters, grow them, and place them on the market in a plump or fat condition: the former are oyster producers; the latter, oyster merchants. On some producing grounds suitable portions of the beds may be utilised for rearing oysters for direct sale to the public, while on well-stocked fattening grounds good crops of young oysters may sometimes be obtained. Other beds, which have been condemned as being liable to pollution by sewage, may still be used for oyster culture, but all oysters produced on them must be transplanted for purification[14, 17] before being offered for sale for consumption.

NATURAL OYSTER CULTIVATION.

The cultivation of oysters (hereafter assumed to be *O. edulis*) may be considered in three natural stages: (1) oyster production, (2) growth culture, (3) fattening, but during all these stages the care of the beds forms an important fourth section of the work.

Oyster Production.

Individual female-functioning English oysters (*O. edulis*) produce from a few hundred thousand to about $1\frac{1}{2}$ million eggs in a breeding season, according to the size of the individual. The eggs are laid inside the shell and are retained there by the parent until they develop into freely swimming individuals (*larvæ*) which, after a short hazardous life, 10 days or more,[1] in the tidal streams, settle down on any suitable clean object and transform themselves into the sedentary young oyster, which at this stage is called an oyster *spat*. The season's settlement of young oysters is thus called a *spatfall*.

The primary object of the oyster producer is to secure a large spatfall. To attain this object the oyster cultivator must know the main facts regarding breeding and the best conditions for the settlement of the larvæ, and must keep a reasonably large stock [2] of large spawning oysters to ensure a spatfall in only moderately good seasons. The beginning of the breeding season in *O. edulis* varies locally and with season according to the weather conditions from about the middle of May to the beginning of July. On English beds it has been found that breeding begins in a fair proportion, 10 to 20 per cent [3] of the population, soon after a temperature of 60° F. or above is maintained in the bulk of the seawater. In practice the oyster cultivator examines [4] samples of oysters at about the usual time breeding begins in a particular locality until a small proportion of blacksick [5] oysters are found. A *blacksick* oyster is one containing larvæ which appear black in mass, in which condition they are ready to begin a free existence (Fig. 1).

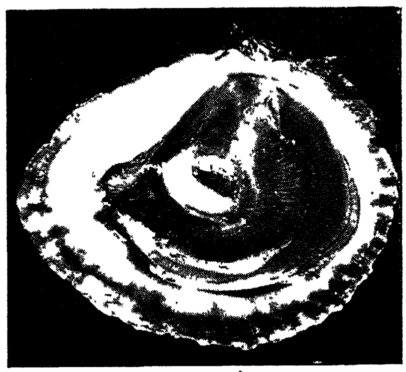


FIG. 1—Photograph of a 'blacksick' oyster. The semi-lunar shaped black area in the upper right part of the shell is composed of hundreds of thousands of shelled larvæ. Individual larvæ may be distinguishable with a lens in the original on the lower middle part of the shell. (× *ca.* ¾.)

As soon as a small percentage [6] of blacksick oysters are found, a previously prepared quantity of clean shell is gradually spread day by day over those portions of the beds known to have secured spatfalls in other seasons. Any kind of clean material, but especially shell, whether of cockles, oysters, mussels, limpets, or clean shell-gravel, and collectively called cultch, may be used. Twenty tons of this material is easily absorbed on even small beds. The English method of catching spat by merely throwing clean shell into the sea is very

simple and primitive in comparison with continental and other foreign methods,[7] but is defensible on the high cost of labour in this country and the (im)probability of adequate economic return on outlay on extra labour costs.

After the distribution of the cultch, the oyster cultivator, like the farmer on land, is—except for nursing the beds—largely at the mercy of the weather. After a long fine summer a good fall of spat may be expected on most well-stocked beds; but the spatfall may fail in some good summers, or in other rare cases be so prolific as to bespatter almost every available object, including some fucoid seaweeds. In cold summers a good spatfall is not expected. These facts prove that certain special conditions, which do not always occur in the sea, are requisite for the proper development of the larvæ and/or the transformation which occurs when the active larva settles down to become the sedentary mollusc. In a good season, upwards to 30 spat on an oyster shell may be found about the middle of July; in a poor one, shells with 2-5 spat may be difficult to find, and, except in prolific seasons, there is probably a heavy mortality at this stage.

Growth Culture.

When the cultivator has obtained a good spatfall, the young oysters are left on the ground undisturbed until at least the following winter or spring, and usually until the size of one inch or more is attained. At about the size of 1½ to 2 inches, the young oysters in the sea begin mostly to grow away from the cultch shell, and can then be, and are, freed therefrom with a knife, one of the operations known as *culling*. Culling the young oysters from cultch is an important operation and permits the animal afterwards to grow into a good shape, that is, with a deeply concave as opposed to a flat shell. After being culled, the young oysters may be returned to the original bed, or relaid on special nursery beds kept for particular size-groups, and left to grow under supervision until required for sale or relaying on fattening beds. Well-shaped oysters grown in the sea rarely attain to more than a length of one inch at an age of one year,[2] and afterwards on the average increase in size (length) with a decreasing yearly increment; on the other hand, flat-growing oysters may grow in length at a greater rate than one inch per year. In the sea, increase in shell area occurs in the spring and again in late summer or autumn, as is especially well shown on the Fal Estuary Beds. In the apparent dormant period in summer there is some reason to believe[8] that the shell may be increasing in thickness. Well-shaped oysters usually grow slowly in size, and rarely attain marketable size before having spent five summers in the sea.

Fattening.

The natural fattening of oysters consists simply in relaying stock on whole beds or parts of beds where previous experience has shown that fattening will usually occur. The oysters fatten themselves naturally, but in the sea there are also good and bad years for fattening, although certain beds rarely fail. Fattening depends ultimately upon the occurrence of an abundant supply of microscopic vegetable food, especially diatoms and peridinians.[9, 10]. In the sea the amount of this food available shows fluctuations,[9, 11] with usually maximal growths in spring and late summer or autumn, and the natural fattening of oysters at the approach of winter is believed to be dependent upon the later maximum.[9] In France, oysters are artificially fattened in ponds or *claires* by feeding them with a superabundance of diatoms. If, therefore, by artificial means a superabundance of microscopic vegetable organisms could be produced cheaply in restricted estuarine localities in the sea, the fattening of the contained oysters, if these were otherwise healthy, would be assured.

In spring and summer the food absorbed is utilised largely in the formation of reproductive products. When an oyster is ready to spawn it is usually in fine fat condition, but in this condition the fatness is due to the great development of eggs or sperm, whereas the fatness attained on the approach of winter is quite different[9] and due to an accumulation of food reserves.[12]

Care of the Beds.

During all the preceding phases of oyster culture a constant watch on the beds is maintained for the purpose of collecting and destroying pests and enemies, such as, on one hand, slipper-limpets, mussels, ascidians, and on some grounds the larger seaweeds, and on the other hand, the oyster-borers, *Murex*, *Purpura*, and *Urosalpinx*, and starfishes. Muddy beds may need to be harrowed, and sandy beds inspected after a succession of gales, or after gales of unusual severity, while constant supervision may be required to prevent or detect poaching.

ARTIFICIAL OYSTER PRODUCTION.

The well-known fact that one individual *O. edulis* at an age of about six years may incubate one million or more young to an advanced stage of development has presented an alluring prospect of easily acquired wealth to experimental cultivators for more than half a century. Many attempts have been made in the past in specially constructed oyster ponds and tanks to obtain young oysters from the millions of larvæ which can easily be obtained in such ponds or tanks, but with economic failure. Large spatfalls have been obtained in some years, followed by complete failure in many others. Such experiments in the past, however, have been based on empirical procedure, and there is no reason to suppose that success will not ultimately be attained as the factors concerned in promoting (1) the healthy life of the larvæ, (2) an easy transformation of the larva to spat, and (3) an assured early development of the spat become known. The experience gained in rearing the larvæ of sea-urchins, crabs, ascidians, limpets, worms, and even crabs at the Plymouth laboratory,[13] all tends to show that the undertaking is more difficult than would be anticipated. The difficulty is also

generally greater when there is—as in the case of the oyster—a metamorphic stage in the development, at which stage there is generally a very great mortality. Academic researches on rearing marine animals have, however, been made only on a small scale, and additional difficulties arise when it is necessary to carry out experiments in a large volume of unchanged—but changing—water.

In recent years the Government Fisheries Department has attacked the problem of the artificial production of oysters in the mussel purification tanks at Conway, with variable, but probably greater, success than has attended previous efforts. The Government experiments were begun on empirical lines in the post-War period, but are now being continued on a scientific plan,[14] which is taking into account all the factors likely to affect a successful issue, such as nature of the larval food, constituents of the water, enemies, as well as temperature conditions; ultimate success in obtaining falls of millions of spat is probably only a question of time. The recent recognition of the importance of the minor chemical constituents [15] of sea-water, especially in a stationary body of water, has widened the scope of these experiments, but at the same time narrows down the possible unknown factors. The problem is thus expanding beyond the province of the biologist, and whether the original staff is big enough—even with hearty outside co-operation—to press the investigation with vigour may be reasonably doubted.

The original idea of these experiments was to discover whether oysters could be produced in bulk in tanks on a commercial scale. Oysters have been produced in large quantities, but the commercial aspect has not yet been sufficiently considered. Millions of oysters may be procured in tanks, but unless a reasonable proportion are eventually put on the market at a profit, the project is commercially unsound. It is desirable, therefore, that a large-scale commercial experiment should be carried out side by side with investigations into the exact conditions for ensuring a large spatfall.

Artificial Fattening.

The success of continental cultivators in fattening oysters artificially leaves no doubt that the same process—if commercially desirable—could be carried out in England by supplying a superabundance of diatoms in tanks or ponds. Such oysters are, however, usually green-gilled, and are not favoured by the English consumer, so that the problem in artificial fattening in England would comprise also the production of a white 'fish.' Recent researches,[10] however, indicate that a superabundance of diatoms and/or peridinians might be obtained in closed estuarine waters by artificially maintaining the slight concentration of essential foodstuffs, phosphates and nitrates, necessary for heavy crops of this planktonic vegetation. Supplied with abundant food of this nature, oysters would fatten naturally and with a minimum of outlay on labour.

Research Problems.

The main research problems in connexion with oyster culture are those concerned with increasing the stock of young individuals and with fattening oysters for the market. While the artificial production of young oysters may eventually be an assured commercial proposition, it is possible that slight improvements in the methods of securing oyster-spat on the natural oyster beds may rival even successful artificial methods in the ultimate return on outlay. Experiments on the treatment of shell-cultch before distribution in the sea, and novel methods of catching spat in the sea are reasonable problems for research.

The liaison between the oyster cultivator and the Fisheries Department is rendered difficult by the private or semi-private nature of most oyster-fisheries, but mutual benefit would undoubtedly follow if a young Government oyster-biologist were assigned the special duty of studying and conducting continuous researches on oyster culture and its problems in all parts of Great Britain. The biologist would be able to help the practical man in everything relating to biology, such as sex, spawning, development, spatfall, feeding, exposure dangers, etc., and in return would learn a great deal about the bionomics of the oyster in its relation to culture,[16] the local problems in oyster culture, and would eventually become a beneficent expert.

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Vitamin D and the Structure of Human Teeth.

In a recent review in Nature (Vol. 121, p. 325; 1928) on the influence of diet upon the teeth, reference was made to the work of M. Mellanby and her collaborators on the effect of diet on the structure of the teeth and on the incidence of caries. More recently the same author has brought forward evidence indicating a definite relationship between structure and the incidence of caries, and has also shown that it is possible to arrest the spread of this condition by suitable alterations in the diet (M. Mellanby, *Brit. Dental Jour.*, Dec. 15, 1927; M. Mellanby and C. L. Pattison, *Brit. Med. Jour.*, vol. ii, p. 1079; 1928).

An analysis of the results obtained from the

microscopic examination of sections of deciduous teeth showed that only 372 out of 1036 sectioned were normal or nearly normal in structure: 27 per cent of these had carious cavities; on the other hand, of the 664 which showed definite defects of structure, or hypoplasia, no less than 85 per cent were carious. The relationship held with each individual type of tooth: thus the incisors, which are usually the best calcified, showed the lowest incidence of caries, whilst the second molars, which are the worst calcified, were the most susceptible. A similar relationship between structure and caries was observed in the examination of 266 permanent teeth. About 10 per cent of each of the different type of teeth appeared to be exceptions to this relationship, a well-calcified tooth showing caries or vice versa. Apart from the fact that some of these exceptions may be more apparent than real, since the classification of a tooth depends on the structure of the part not affected by caries, and this may be well calcified, the disease having commenced in the badly calcified portion, there is a further factor to be taken into account, the possible change in the resistance of the tooth after eruption. Analysis of the structure of the secondary dentine formed in response to disease or injury showed that, in two-thirds of these exceptions, the presence or absence of caries could be correlated with a poorly formed or a well calcified secondary dentine respectively. This latter observation has a further importance in that it indicates that the resistance of the teeth can be changed after eruption by variations in the degree of calcification of the newly-formed dentine: one factor, and probably the most important, is the diet.

In previous investigations, Mellanby and Pattison have shown that diets favourable to calcification limited the initiation and spread of caries in children and frequently caused a hardening of teeth in which caries had started. In these experiments the diets were improved by giving milk, eggs, and cod-liver oil, thus supplying both vitamins A and D, or were made less satisfactory by increasing the oatmeal content or cutting down the vitamin intake. The present work was undertaken to see whether the good effect of cod-liver oil, for example, was due to its vitamin A or vitamin D content: it appears to show that vitamin D has a marked influence in preventing the spread of caries in children and in promoting its arrest, whilst vitamin A probably has no, or only a slight, effect.

The work described deals with the influence of vitamin D, supplied in the form of irradiated ergosterol (1 to 4 c.c. radiostol solution daily). A group of 21 children was placed on a complete average diet, supplemented by the addition of the irradiated ergosterol: the test lasted twenty-eight weeks and the amount and extent and degree of hardness or softness of each carious area were noted in each child at the beginning and end of the experiment. The average age of the children was less than six years. The results obtained were somewhat better than in the previous tests and showed that the addition of the vitamin D had a pronounced effect in preventing the initiation of new carious foci, limiting the spread of the disease, and apparently arresting its progress in many cases. Owing to the younger age of the children of this group, however, somewhat better results might be expected, since there is presumably less interference with the pulp tissue of the teeth by the natural processes of root absorption which occur at a later age.

When only the results obtained with children less than six years of age in the previous tests were compared with those of the present experiment, it was found that the radiostol supplement was only slightly more effective than the addition of cod-liver oil, extra eggs, and milk to the diet. Thus the average number of teeth per child showing initiation or increase of caries was 1·0 and 1·4 respectively in these two groups; on the diet containing little fat soluble vitamins and additional oatmeal the figure was 5·0 teeth per child; whilst on a diet containing no oatmeal and only a moderate quantity of fat soluble vitamins it was 3·3. The average amount of hardening or arrest of caries per child was, in the four groups, 3·9, 3·7, 0·2, and 1·2 respectively. Put in another way, the 21 children had 185 carious teeth at the beginning of the investigation: 4 new points appeared during the experiment, 2 in one child: 16 areas showed some spread of the disease, 4 being found again in one child, who was apparently given too little of the irradiated ergosterol. In the majority of the teeth the soft and active caries was in course of arrest, or had actually been arrested, so far as could be ascertained. Microscopic examination of some of these teeth indicated that the process of healing was accompanied by the laying down of well-calcified secondary dentine.

If these results can be confirmed in adults, they will be of great importance owing to the widespread prevalence of caries among civilised populations to-day. In a recent review on the subject of the influence of diet upon the teeth, M. Mellanby discusses the question whether the incidence of caries can be explained by the nature of the diets consumed, and concludes that such may indeed be the case (*Physiol. Reviews*, vol. 8, p. 545; 1928). The two factors which favour the development of caries are the consumption of large quantities of cereals and the small intake of the foodstuffs which contain vitamin D, milk, butter, cheese, and eggs. If an inadequate intake of this vitamin is only a partial cause of the prevalence of caries, this deficiency must be very widespread amongst all grades of society in civilised nations to-day.

It will be of great interest to see if the spread of caries can be prevented by the administration of irradiated ergosterol in some form to adults: if, as seems probable, this will be the case, then a simple method of preventing dental decay will be available and will be a great stimulus to an increased consumption of milk and milk products, with further benefits to health and well-being, or, for those who prefer it, the diet can be supplemented by a synthetic vitamin D preparation.

Obituary.

Sir W. T. Thiselton-Dyer, K.C.M.G.

William Turner Thiselton-Dyer, son of Dr. W. G. Thiselton Dyer, was born in Westminster on July 28, 1843. At King's College School, where his contemporaries included Prof. Saintsbury and the late Dr. Henry Trimen, Dyer was first mathematical scholar: as schoolboys Trimen and he were companions on botanical excursions near London. Matriculating in the University of London, Dyer entered King's College, meaning, like Trimen, to study medicine: in Dyer's case the intention only went far enough to qualify him for eventual admission to the Society of Apothecaries as a 'member by apprenticeship.' At King's College his contemporaries included Sir Charles Lyall, whose participation in Dyer's botanical pursuits made them companions in a vacation walking tour, and provided Lyall in after life with relaxation from the tasks of an Indian official and the studies of an Oriental scholar. This friendship, and the fact that relatives of his father were resident in Madras, while his maternal uncle, T. A. C. Firminger, author of the classic "Manual of Gardening in India," was a chaplain in Bengal, may have induced the idea of an Indian career under which Dyer, at twenty, went up to Christ Church, Oxford, as a Junior Student whose mathematical aptitude and classical proficiency had left unimpaired his early botanical interests.

At Oxford, where Dyer took his degree in mathematics, any thoughts of an Indian career disappeared. He came under the influence of Profs. Rolleston and Daubeny, and formed intimate friendships with his contemporary Prof. H. N. Moseley and their junior, Sir Ray Lankester, who migrated from Cambridge to Christ Church in 1866. His friend Trimen, who had graduated as M.B. London in 1865, at once adopted a botanical career, and in 1866, Dyer collaborated with him in the preparation of their "Flora of Middlesex," which was published in 1869. In 1867, Dyer obtained a first class in the Oxford final Natural History School, and in 1868 became professor of natural history in the Royal Agricultural College, Cirencester. Here he found in Dr. A. H. Church, professor of chemistry, a colleague on whom the influence of Daubeny had also been marked. Impressed by the Yale text-book, "How Crops Grow," Dyer assisted Church to prepare an authorised edition of Prof. S. H. Johnson's work, adapted to English conditions, which appeared in 1869. In 1870, Dyer graduated as B.Sc. London, and was appointed professor of botany in the Royal College of Science, Ireland. Early in 1872 he was again in London: on Jan. 17 he was appointed professor of botany to the Royal Horticultural Society, and assumed office on Feb. 13. Two days later he was elected a fellow of the Linnean Society.

While working for the Horticultural Society at Chiswick and South Kensington, Dyer gave assistance to the director of Kew, the delegates of the Clarendon Press, and the professor of biology in the Royal College of Science. His work at Chiswick included plant identification. This entailed contact with Kew, and brought him an invitation to assist in preparing the "Flora of British India," the first part of which appeared in May 1872. By 1873, Dyer had described the Indian species of six natural families of flowering plants: his contribution, which includes an emendation of the "Genera Plantarum" of Bentham and Hooker, was issued in January 1874. The Clarendon Press had undertaken to publish an English edition of a 'Text-book of Botany' by Prof. Sachs: Mr. A. W. Bennett was employed to translate, Dyer was engaged to edit this work, which was published in 1874. The transfer of the School of Mines from Jermyn Street to South Kensington enabled Prof. Huxley to initiate his laboratory course of biological instruction. Dyer became one of Huxley's demonstrators, and was left to organise and conduct the botanical part of the course, which began on June 24, 1873, and was much appreciated: in May 1874 he was elected to the Council of the Linnean Society.

When Dr. J. D. Hooker became director of Kew in 1865, the assistant-directorship he had held during 1855–65 was suppressed. In 1875 the assistant-directorship was revived: Hooker was asked to select an incumbent. That year Dyer began his share of Huxley's course on Mar. 6: on June 16 he informed the Horticultural Society that he had been appointed assistant-director of Kew, and resigned their service. Dyer's duties under Hooker at Kew did not deprive Huxley of his help at South Kensington; in 1876, Dyer's South Kensington course opened on June 24; in 1880 it began on July 7.

Hooker assigned to Dyer, as assistant-director, the conduct of the colonial activities of Kew: almost the first of his tasks was to have historic consequences. It was thanks to Dyer that in the autumn of 1875, Peradeniya received the young *Hevea* plants, the progeny of which now stocks the rubber plantations of Ceylon and Malaya. It was Dyer who in 1880 sent his friend Trimen, then director of the Peradeniya garden, the selected varieties of Cacao from Trinidad still grown in Ceylon. When, in 1877, Dyer became Hooker's son-in-law, he was given charge of a laboratory for original investigation by workers of any nationality, erected at Kew by a private donor in 1876: under Dyer's management it became, in American judgment, "the best botanical laboratory in Europe." When, in 1882, another private benefaction gave Kew a rock-garden, its design and construction were entrusted to Dyer. In 1880, Dyer's work for Huxley at South Kensington secured his election to the Royal Society: his work for the Colonial Office was recognised by his being created C.M.G. in 1882. In 1884 he was again elected to the Council of the Linnean Society; in 1885, when Hooker retired, Dyer was appointed director of Kew.

As director Dyer at first experienced many calls on his time. He served as vice-president of the Linnean Society, 1885–87; on the Council of the Royal Society, 1886–88; as vice-president of the

Horticultural Society, 1887–89; as a fellow of the University of London, 1887–90. He now resolved to avoid such distractions from official duty, carrying his resolution so far as to decline nomination as president of the British Association; the only exception to his self-imposed rule of 1890 was his service as vice-president of the Royal Society in 1896–97. This rule could not apply to official commands: he had served as a Royal Commissioner for the Melbourne Centennial Exhibition in 1888; he served in the same capacity for the Paris International Exhibition in 1900, and for the St. Louis Exhibition in 1904. Nor did he decline service on committees appointed by the Royal and other societies to deal with specific matters of public importance. Perhaps his most valuable work of this kind was that connected with the Chelsea Physic Garden. As a member of the Corporation to which, since 1673, the Chelsea Garden belonged, and as director of the younger sister institution that public apathy in 1837 had placed in equal jeopardy, Dyer took the initiative in the movement which in 1899 saved the Chelsea Garden from impending destruction.

The intercourse between Kew and India of 1778–1815 was renewed when Kew became a national institution in 1841. Though India Office councillors and secretaries were but rarely botanists like Dyer's friend Lyall, they were usually acquainted with India and its peoples, and could appreciate the bearing of the work at Kew on economic questions with which they were familiar. This intercourse Dyer maintained: in 1892 he was created a C.I.E. As assistant-director, Dyer had induced a similar appreciation of Kew at the Colonial Office, where personal knowledge of our many tropical possessions was necessarily less general. As director, Dyer was now consulted as regards policy. The advice he gave was simple and effective. From 1887 onwards colonial administrators copied the course followed by the East India Company from 1778 onwards. Botanic stations were set up, under competent curators in direct correspondence with Kew: to assist these stations Dyer in 1887 founded the *Kew Bulletin*. The success of this policy was explained to the House of Commons by the Colonial Secretary on Aug. 2, 1898: in 1899, Dyer was created K.C.M.G. The satisfaction felt by overseas correspondents of Kew was shared by Christ Church: Dyer was elected an honorary Senior Student. But a sacrifice was exacted. The assistant-director of Kew, Dr. D. Morris, became Imperial Commissioner, West Indian Agricultural Department: history repeated itself; the assistant-directorship again fell into abeyance.

Though it has been remarked that Dyer's success was largely due to "his intense feeling for the living plant," he realised that without a herbarium a botanic garden is like a rudderless ship: he described the Dipterocarps of India for Hooker the year he organised the botanical portion of Huxley's course. Dyer saw the Kew herbarium extended in 1877, and had to double it himself in 1902. As director he inherited the botanical survey of our overseas possessions undertaken by the elder Hooker at the request of Government. A flora of South Africa, begun in 1859, was suspended in 1865; one of Australia, begun in 1863, was completed in 1878. A flora of tropical Africa, begun in 1868, was suspended in 1877; that of British India, begun in 1872, was still in progress in 1885. Dyer devoted the herbarium resources to furthering the Indian flora; only with the end in sight did Dyer resume the flora of South Africa in 1896; only when the Indian work was completed in 1897 did he resume the flora of tropical Africa. Dyer's competence as a descriptive botanist made him a perfect editor: abstaining from personal contribution to the text of either flora, he was able to edit both.

Dyer obtained relief, when he persuaded his friend, Dr. D. H. Scott, to assume honorary keepership of the Jodrell laboratory, which enabled him to reorganise the museum collections; to improve the lecture course for young gardeners; and to convert into a corps the groups of uniformed attendants at Kew on whose efficiency and courtesy the safety of the collections and the comfort of visitors depend. With the interests of this corps he associated himself; he made it a personal charge, and wore the uniform of its inspector.

Dyer's "intense feeling for the living plant" was shown in 1887 when he provided an Alpine house as an annex to the rock garden; was apparent in the energy with which he replaced outworn conservatories and modernised plant-houses structurally sound; and was especially manifest in his work on the outdoor collections. What Dyer accomplished is best appreciated by those who realise that Kew owes to Sir William Hooker, director 1841–65, its salient features such as the lake and the great vistas; that it owes to Sir Joseph Hooker, director 1865–85, the condition and arrangement of the collections of hardy trees and shrubs, as well as the avenues in the arboretum and the paths in the pleasure grounds that make the collections accessible. Dyer brought to bear on what his predecessors had provided, the care and skill of an artist able to produce landscape effects that "should be suave and ample." Again his method was simple and his success striking. Without any sacrifice of scientific interest he gave access to the glades, and laid open the informal vistas that induce at Kew a sense of space and bring into view objects that attract attention.

In 1899 the winter-garden, left unfinished since 1862, was completed: a Secretary of State indebted to Kew for scientific assistance had secured, in 1894, the review of a decision with which, for a generation, the public department in charge of the gardens had concurred. That department, admirably qualified to administer Kew as a place of public resort, now strove to control the official correspondence of Kew as a scientific centre. The difficulty as regards the department chiefly concerned was overcome when Dyer, in 1902, was appointed botanical adviser to the Secretary of State for the Colonies. To obviate its recurrence, Kew was transferred in 1903 for administrative purposes to a new department, sympathetic with the scientific activities of Kew, but without

experience as regards places of public resort: in 1905, Dyer retired from Kew, but retained his Colonial Office appointment until 1906.

At Witcombe, in Gloucestershire, where Dyer now settled, he took for a decade an active part in the business of the county, for which he became a justice of the peace. In 1908 he was appointed the representative for the University of Oxford on the County Education Committee, and in 1909 became a member of the Court of the University of Bristol. On behalf of Kew he continued to edit the "Flora of Tropical Africa" until 1913, and the "Flora Capensis" until it was completed. Meanwhile at Oxford it had not been forgotten that Dyer was a scholar as well as a biologist, to whom, in both capacities, Daubeny had imparted his own keen interest in the identity of classical plants: Dyer undertook to assist those engaged in revising the lexicon of Liddell and Scott. In 1916, Dyer reviewed his obligations much as he had done in 1890, and, as a result, resigned a position in the Royal Horticultural Society, to which he had been appointed when Hooker died in 1911; relinquished the seat on the County Education Committee which he had occupied since 1908; left the Athenæum, to which he was elected 'by the Committee' in 1885; and retired from the Royal Society. His work for the editors of the new Liddell and Scott had involved much careful investigation: from 1916 until his death on Dec. 23, 1928, Dyer's time, when health permitted, was largely spent in continuing his classical studies, and amassing material for a glossary of ancient plant names.

Transparent honesty of purpose and rigid accuracy of statement were, in the case of Dyer, associated with clear vision, firm decision, and prompt action. Direct in speech and incisive in style, his intention could never be mistaken. To these qualities, which made him a wise adviser and a faithful friend, were added a mine of knowledge and a width of culture, that made social intercourse with him an intellectual feast. With these qualities, that were attractive, were associated two habits that, though only defects of his merits, at times interfered with his influence as a man of affairs. His instinctive dislike of ambiguity, which included aversion to any attempt at compromise of principle, induced a habit of which he was conscious, that endeared him to correspondents abroad, but was disconcerting to colleagues in Great Britain. The other habit, of which he was evidently unconscious, caused him to wound the susceptibilities of many of those whose views he found himself unable to accept. To this latter habit may be attributed Dyer's failure to find support for proposals that, when afterwards submitted by others, were accepted without debate. In his choice of men Dyer paid more regard to character, of which he was only a tolerable judge, than to capacity, in the assessment of which he was singularly successful.

The type of botanical teaching of which Dyer was the pioneer in Britain has induced an academic impression against which Dyer's administrative activities were an eloquent though silent protest: to that impression we owe the modification of his colonial policy. Dyer's work for Kew will survive long after his precise share therein has been forgotten. Should it prove possible to make available the fruits of the labours of his later years, it may be that in these will be found an even greater claim to grateful remembrance. As it is, Dyer has placed mankind under two important obligations. His manhood was given to teaching science that the improvement of natural knowledge for use is a service as honourable as the improvement of natural knowledge for discovery: he used the leisure of his later years in reminding letters that the interest of science in the 'humanities' may be as great as that of scholarship. Both are lessons still badly needed.

THE story of Thiselton-Dyer's life as related above by another contributor is only half told if his wide knowledge of ancient botany and of classical literature be not recorded and appraised; for besides being an eminent botanist and a first-class man of affairs, he was a scholar of wide reading and meticulous accuracy.

Sooner or later men come back to what they loved as boys; and Dyer told me once that Martyn's "Georgicks" had been his favourite school-book. John Martyn, F.R.S., was professor of botany in Cambridge in the middle of the eighteenth century; his two books, one an edition of the "Georgicks," the other of the "Bucolicks," were school-books for a hundred years, and it is a pity that they are used no more. The very pictures in Martyn were delightful: the olive-tree and the 'hyacinth,' the *cerinthæ ignobile gramen* beloved of bees, the *flos in pratis cui nomen amello,* the figure and description of Virgil's plough, and the picture of the northern heavens with the Dragon winding like a river between the Great and Little Bears—one remembers them all. In the botanical chapter which Dyer wrote for Sir John Sandys' "Companion to Latin Studies," while nothing of moment is left out, yet Virgil always has the middle of the stage; and Martyn's two books head the long list of quoted authorities. Dyer was always fond of old books, and liked (as he said) to "take stock of the harvest of accurate and acute observation to be found in the writings of authors now almost fallen into oblivion, yet long recognised as classical." He bought a Clarke's Odyssey for half a crown when he was a schoolboy, in a small book-shop, "a mere open booth, in the purlieus of Leicester Square"; and he used it to the last, because it "gave the comments of Eustathius, which no modern editor will look at."

Thiselton-Dyer took his degree at Oxford in mathematics, a fact which I have not seen mentioned; he was proud of it, and prouder still that he had been a pupil of Henry Smith's. "Is it not recorded" (he says in one of his letters to me) "in the preface to the Cambridge edition of his works? *That* I think earned me more respect from L . . . r than he would have bestowed on what Augustine Birrell called a 'mere botanist.'"

Thiselton-Dyer's classical papers are few in number and represent imperfectly his vast stores

of knowledge. His unrivalled knowledge of Greek plant-names he gave freely to the new edition of Liddell and Scott, regretting all the while that much useful and appropriate matter, the great mass of his accumulated notes, could find no place therein. He knew, as many another scholar knows, that what we wanted was no mere Lexicon but a "Thesaurus," and that England should have been rich and generous enough to let her scholars make one. But Liddell and Scott held the field and "queered the pitch," he said; and though he loved the great book, all the more because it hailed from his own College, he spoke of it as "So-and-so's dry-as-dust pemmican,—if you can conceive the similitude."

Apart from his contributions to the Lexicon and his two chapters in the Companions to Latin and Greek Studies, Thiselton-Dyer's chief writings on classical botany are found in the *Journal of Philology*, now dead, which flourished under the editorship of Ingram Bywater and Henry Jackson. Dyer wrote at least three papers for that journal, these three including articles on about thirty "Ancient Plant-names," all more or less obscure and difficult. One of the smaller articles (by way of example) was on the ἐλαίαγνος, a plant mentioned by Theophrastus, which the old Liddell and Scott called "a Bœotian marsh-plant, perhaps *myrica* or *sweet-gale*." Dyer had no difficulty in showing that it was not *myrica*, which means tamarisk, nor was it sweet-gale, which is a northern plant unknown in Greece. He showed in the end that the word were better written ἐλέαγνος, which is plain Greek for a marsh-lambkin; and that Theophrastus's plant was nothing but the common goat-willow, *Salix caprea*, whose catkins country-folk still call "lambs' tails." For a more elaborate essay take the one on *Amomum*, a very difficult word, which Thiselton-Dyer traced up and down through an immense field of old literature. He begins by showing, from Theophrastus, how both Amomum and Cardamomum came from India; and how when Pliny and Dioscorides call them natives of Media, Pontus, and Armenia, these are but the trade-routes by which they came. Pliny's Cardamomum is easily disposed of; it is the common Malabar Cardamom of the apothecaries. Amomum is much more difficult; but Dyer shows how Pliny's description of it as a shrub (*frutex*), growing on the mountains (*montuosus*); with its spiny inflorescence on a short stalk (*palmi altitudine*); with its scaly leaves or bracts "like those of a Pomegranate," which soon turn dry and brittle (*posterius fragile*), and need to be gently handled and kept together (*manipulatim leniter componi*),—how all this tallies word for word with the Nepaul Cardamom (*A. subulatum*) of the Himalayan slopes, still used in India as a cheap substitute for the real thing. He then discovers the very same identification in the rare "Commentatio de Amomo" of Nicolo Maragna, a Veronese physician, whom Caspar Bauhin quotes in his "Pinax." Lastly, he proceeds to discuss, carefully and patiently, the uncertain source and difficult etymology of the word.

No busy and laborious man ever finishes his life's work, no good man reaps all the harvest he has sown. But it is earnestly to be hoped that what Thiselton-Dyer has left behind, ungarnered and unpublished, may see the light of day. Just eight years ago he wrote me: "I have projected a Glossary [of classical Plant-names], and the Clarendon Press profess to be willing to print it. I have the whole thing in slips, and I go on annotating. . . . But whether with impaired health I shall be able to accomplish a fair copy for the printer is a problem." A sympathetic and friendly biographer said the other day that Thiselton-Dyer would be "remembered as a great botanical administrator." Even such qualities as he possessed and such services as he rendered in this capacity will, I think, prove less memorable than the scholar's task which was the pastime of his busy life and the occupation of his later years. D. W. T.

DR. S. J. MAUCHLY.

SEBASTIAN JACOB MAUCHLY, physicist with the Department of Terrestrial Magnetism of the Carnegie Institution of Washington since 1914, died on Dec. 24, at his home in Chevy Chase, Maryland, after a long illness. Dr. Mauchly, who was fifty years of age, specialised in terrestrial electricity, and as chief of the Section of Terrestrial Electricity of the Department was responsible for the development and improvement of many instruments for observing the electric elements at field and observatory stations. He made numerous valuable contributions to this branch of science and was the first to direct attention to the apparent universal twenty-four hour term in the diurnal variation of the earth's electric field. This fundamental result was deduced by him largely from his discussions of the work at sea by the *Carnegie*, and he later corroborated this conclusion by extensive investigations of results at land stations over the entire globe. He was also chief of the solar eclipse expedition of the Carnegie Institution of Washington to Lakin, Kansas, in 1918, and co-author of Vol. 5 of Researches of the Department of Terrestrial Magnetism, 1926.

Dr. Mauchly received his educational training at the University of Cincinnati, where in the Department of Physics he took the degree of A.B. in 1911, and as Hanna research fellow, that of Ph.D. in 1913. He was a fellow of the American Physical Society and the American Association for the Advancement of Science, and a member of the American Geophysical Union, International Geophysical Union, Washington Academy of Sciences (serving on the board of editors of the *Journal*, 1925–26), and of the Washington Philosophical Society (recording secretary 1919–21).

WE regret to announce the following deaths:

Mr. Bernard Coventry, C.I.E., first director and principal of the Agricultural Research Institute and College, Pusa, Behar, on Jan. 26, aged sixty-nine years.

Prof. Johannes von Kries, of Freiburg im Breisgau, the distinguished physiologist and editor of the third German edition of Helmholtz's "Physiological Optics," on Dec. 30, aged seventy-five years.

News and Views.

SIR ALFRED EWING's intimation that he desires to retire from the principalship of the University of Edinburgh on Sept. 30 came as a great surprise to his colleagues. He refers in his letter to the University Court to the fact that in a few weeks he will be seventy-four years of age, but his friends have noted no sign of failing in his wide scientific outlook or in his grasp of the business of the University. Since 1916, when Sir Alfred was offered and accepted the principalship in succession to the late Sir William Turner, the University has expanded greatly—thirteen new chairs have been founded. Especially noteworthy is the acquisition of a site of 115 acres on the southern edge of the city, on which now stand the departments of chemistry and geology, and on which the new departments of zoology and animal breeding are in course of erection. Other extensions include the purchase of premises near the Old College for English and modern languages, the reconstruction of the Department of Surgery and the building of a laboratory for clinical medicine at the Royal Infirmary. Early in his tenure of office Sir Alfred successfully carried through the negotiations which resulted in the admission of women to full privileges as students in the Faculty of Medicine, and later he brought into closer co-operation with the University the Training College for Teachers and the Edinburgh and East of Scotland College of Agriculture, the heads of which are professors in the University. Sir Alfred has shown himself throughout to be a man of great energy and resource. He has never spared himself when he could serve the University, and he has done much to bring about a better understanding between the University and the city. It was entirely fitting, therefore, that at a meeting of the Lord Provost's Committee, held on the day on which Sir Alfred's resignation was announced, it was unanimously resolved to recommend that the freedom of the city be conferred upon him.

THE paper read by Mr. G. Fletcher at the Royal Society of Arts on Wednesday, Jan. 30, on the Shannon hydro-electric scheme, attracted a very large audience. It will be remembered that four years ago the Irish Free State decided to undertake an ambitious scheme for supplying hydro-electric power to Ireland. The scheme was devised by an eminent firm of German electrical engineers, and after being slightly modified by a committee of four continental experts, who spent a few weeks making a local study of the problem, was adopted, the whole undertaking being at the expense of the Government. Provision was made not only for the existing needs of a large part of the country, but also for the needs of industries which it is hoped will be established when power is available. Next October the first stage of the scheme is to be completed, the expense up to this stage being about five million pounds.

THERE are about 130 towns and villages in the area of supply of the Shannon hydro-electric scheme which have not an electric supply. It is proposed to charge consumers on the basis of 2*d.* per unit and an additional charge varying from 6*d.* to half-a-crown per week, depending on their Poor-law valuation. For small houses the wiring will be done on the hire-purchase system, a fixed weekly charge being made until the cost has been refunded. Public institutions and factories will be charged 6d. per unit for lighting. As Dublin has a very active and efficient municipal supply by steam generating plant, it is difficult to see how it can benefit from the Shannon scheme. The annual cost of the interest and the power losses in the 'grid' to Dublin from the Shannon power house will be very appreciable. Whilst it is easy to criticise the scheme from the business point of view, the new power station when finished will be a valuable asset. Every effort must be made to attract industries requiring electric power to Ireland. The danger lies in political pressure leading to a rapid expansion of the grid unjustified by the demand and to the scrapping of profitable steam undertakings.

A NUMBER of papers dealing with band spectra have appeared recently in the *Proceedings of the Royal Society*. Following on the investigations of Lord Rayleigh on mercury, and of Prof. W. E. Curtis and Dr. Jevons on helium, and of Sir Robert Robertson on ammonia, phosphine, and arsine, to mention only a few of the more important that were published last year, there is now a group of six communications by various authors in the first number of the *Proceedings* for 1929. One of these, by Dr. Kapuscinski and Miss Eymers, on intensity measurements in the secondary spectrum of hydrogen, is purely descriptive, although it constitutes a valuable appendix to the wave-length tables of this spectrum which were recently issued from Bonn, and provides rich material for its further analysis. The other papers all deal with problems of molecular structure, and include independent contributions by Dr. R. C. Johnson and Dr. Jevons on the spectra of certain fluorides, a paper by F. A. Jenkins and H. A. de Lazlo on the celebrated bands of silicon nitride, and one by J. M. Walter and S. Barratt on the band spectra associated with the vapours of zinc, cadmium, and mercury.

THE main interest of band spectra appears now to have shifted to the problems which have been raised by the new mechanics, and to the elucidation of the nature of the electronic transitions involved in the production of bands in the visible and ultra-violet regions. In cases where a definite decision is possible, the new quantum theory, here as elsewhere, predicts results which are in better agreement with experiment than those which would follow from the older quantum theory; in the matter of electronic energy levels, there can also be little doubt that the theories which are being developed by Dr. Hund in Germany and by Prof. Mulliken in America, to which several references have been made in NATURE, are essentially correct, although there still remains a great deal to be done in this connexion. It is unfortunate that very many

substances which give rise to well-developed band-spectra cannot be isolated as chemical individuals; there seems to be no immediate prospect of obtaining molecular helium outside of a discharge tube, for example, and even the fluorides which were mentioned above are probably chemically unstable or unimportant compounds. Hydrogen and carbon monoxide are two notable exceptions *inter alia*, and in such cases identity of the molecular constants deduced from the band spectra and from physico-chemical data respectively provides a valuable test of the theoretical interpretations of both sets of measurements.

CABLE advices from the *Carnegie* after her arrival at Callao on Jan. 14 state that on Jan. 8 a new submarine ridge, which has been named Merriam Ridge, was discovered. At the point of crossing, Merriam Ridge is ten miles wide and rises 3000 metres above the 4000-metre depth on either side. The top of the ridge, in lat. 24° 57′ S., long. 82° 15′ W., is at 1168 metres, this value being checked by three sounding methods, namely, sonic, wire, and thermometer, to within 20 metres. When 60 miles west of Callao, the surface temperature, which had been 21·5° C., dropped to 19° C. and remained at that value until arrival at Callao. Captain Ault's report shows that the activities in the various observational programmes are being successfully continued, the work between Easter Island and Callao (Dec. 12, 1928–Jan. 14, 1929) including 38 declination stations, 15 horizontal-intensity and inclination stations, 17 oceanographic stations, 72 sonic depth stations, 12 pilot balloon flights, 25 complete photographic 24-hour potential-gradient records, 4 24-hour series of other atmospheric-electric observations, 20 biological stations, 6 evaporation series. The vessel was expected to leave Callao about Feb. 3 en route to Papeete, Tahiti, Society Islands, where she is due to arrive early in March.

PRIOR to the War, all the medical schools of the University of London (with the exception of the London School of Medicine for Women) were restricted to men, but it will be remembered that during the War seven of the schools admitted women in addition. These facilities for women were withdrawn a short time ago, except in the case of University College Hospital, which still admits a limited quota. The action of the authorities of the medical schools aroused considerable discussion, and a Committee was appointed by the Senate of the University of London "to consider the question of the Limitations placed upon the Medical Education of Women Undergraduates." According to the report which has just been issued, it is considered that the facilities in London for *pre-clinical* instruction of women are ample, and it is only the withdrawal of those for *clinical* instruction which has given rise to the present inquiry. The Committee thinks that there is no valid argument against the provision of co-education, but that co-education to be successful must be voluntary. No countenance is therefore given to the suggestion which has been made that the University should enforce a policy of co-education upon the medical (and other) schools by withdrawal of recognition or other means. Such a policy, to be logical, would have to be applied all round, and this would force men upon women's colleges, and men upon the London School of Medicine for Women! Nor does it seem desirable that co-education should be universal in the medical schools of London, for such a policy might result that in some schools there would be only a very small number of women—possibly only one woman—which on various grounds is highly undesirable. The Committee recommends, therefore, and the Senate has given general approval, that its report be communicated to the schools in the Faculty of Medicine, and that the vice-chancellor be requested to invite them to consider the possibility of admitting a quota of women students in the future.

THE Joint Expedition of the Percy Sladen Memorial Fund and the American School of Prehistoric Research, which has recently been investigating caves in the Sulaimani district of north-east Iraq, has discovered Palæolithic remains in two of the sites in which soundings were made. A small cave near Zarzi, about 30 miles north-west of Sulaimani, which was excavated completely, yielded an abundant late Upper Palæolithic industry which has marked affinities with the Upper Aurignacian of Central Europe and of the Grotte des Enfants at Mentone. The presence of Tardenoisian microliths in the upper part of the deposit shows that this industry, although typologically Aurignacian, represents the final development of the Upper Palæolithic in a region into which the Magdalenian never penetrated. The second Palæolithic site discovered was near Hazar Merd, 10 miles due west of Sulaimani. A large cave known locally as the 'Dark Cave' (*Ashkot-i-Tarik*) contained Mousterian hearths three metres in thickness, underlying a mixed layer with pottery of various ages. The Mousterian industry is true to type, and contains no elements that are not already well known in the Mousterian of Europe. It is marked by an abundance of well-made points and a relative scarcity of side-scrapers. Owing to its size the 'Dark Cave' could only be partially excavated, but it is hoped that the American School of Prehistoric Research will be able to complete the work next season. These are the first recorded Palæolithic finds in southern Kurdistan, but there is no doubt that the whole area is rich in promise, and the comparatively settled state of the country should now make it possible to carry on work in this region, which for many years has been practically closed to Europeans.

THE executive committee of the Cambridge Preservation Society, which was formed in March of last year, has published a short statement of a particular part of its work during the past year. It was felt that at all costs the pleasant road to Madingley, the view from Madingley Hill and the approach to Coton village by the footpath should be secured. Finding that the risk was acute, it was decided to use whatever funds were available to this end. Assisted by Col. ffennell of Whytham, near Oxford, Prof. Trevelyan, and other benefactors, the Society was enabled to purchase for £22,300 about 380 acres of land, including the south side of Madingley Hill. The danger to a most beloved part of the countryside west of Cambridge has thus

been averted for the time, but by the acquisition of this land the Society has incurred a considerable debt. The generous benefactors who have lent money must be repaid, and it is certain that further help will be required. The Society intends, however, to postpone to a later date any public appeal for funds in order not to interfere with the efforts of the University to raise money for meeting the conditions of the recent benefaction from the International Education Board.

AMONG the many scientific investigations being made into food storage and preservation are those relating to the handling and carriage of fruits to Great Britain from various parts of the Empire, and every fruiterer's shop in London is evidence of the value of those investigations. Few people, however, realise the extent of our fresh-fruit trade with Australia and South Africa, the latter of which exports annually 27,000 tons of soft fruits such as grapes, pears, and peaches, and 45,000 tons of citrus fruit, principally oranges. A few years back, such fruits were placed directly in the refrigerated holds of ships and much waste occurred. To-day, all the fruit is pre-cooled before shipment, and *Engineering* for Jan. 25 contains a description of the buildings and methods used at Cape Town for this purpose. Fruit on arrival by train is run into a large insulated air-lock, unloaded on to standard-size trolleys and then electrically hoisted and traversed into cooling chambers, of which there are 72, each capable of holding 12 trolleys. Soft summer fruits such as grapes and peaches are then cooled from 90° to 34° F., while winter fruits have to be cooled from a temperature of about 60° to 40° F. In shipping, the trolleys are run out and hoisted directly aboard. Many problems of construction, refrigeration, and insulation were involved in the design of the building and machinery, the consulting engineer for which was Mr. E. A. Griffiths, physicist to the South African Government.

SIR WILLIAM BRAGG delivered the first of a course of three lectures at the Royal Institution on "The Early History of X-Rays" on Jan. 31. Sir William stated that no scientific discovery before or since that of Röntgen in 1895 has excited such immediate or universal interest. The effect was all the greater because scientific workers everywhere were able to repeat the experiment without difficulty. From a scientific point of view the new departure was equally remarkable. As Maxwell pointed out long ago, the problem of the relation between electricity and matter was more likely to receive explanation from the study of the electric spark than in any other way, but the key had not been found in 1895. Röntgen's discovery so increased the facilities for experiment, and was so suggestive of the directions in which to move, that the world was soon led to the recognition of the electron as the all-important factor. Before 1895 the wealth of experimental results lacked co-ordination. The work of Faraday had shown that molecules in a liquid were broken into parts of which some carrying negative electricity moved towards the negative and others towards the positive pole. But the puzzle was as to why it was so easy to send the current through the liquid and so difficult to send it through a gas. Yet in certain circumstances, such as heating by a flame or the action of ultra-violet light, a gas could be made to conduct quite well. It became clear that the molecules of the gas must be broken before the electricity could pass, just as in a liquid. The knowledge of the fact that the atom was not the unchangeable entity which it had been assumed to be, and that an electron could be torn from it and become free to move and shatter other atoms, was still hidden from the experimenter, and it was this which caused all his results to lack cohesion. But he could at once appreciate the new discovery and move on towards the explanations that were forthcoming almost immediately.

AT a meeting of the Newcomen Society on Jan. 23, Mr. Rhys Jenkin read a paper entitled "A Chapter in the History of the Water Supply of London," in which he dealt mainly with the pumping apparatus erected by Sir Edward Ford on the banks of the Thames a little to the east of Somerset House. Ford, who was born in 1605 and died in 1670, was a royalist soldier of good family and married the sister of Ireton, son-in-law of Cromwell. During the Commonwealth he turned his attention to practical invention, and in 1655 was granted a patent for a pumping apparatus. The patent is not merely of interest in the history of mechanics, but also it was one of only about a dozen such patents granted by Cromwell, and it is the only one the enrolment of which is to be found at the Public Record Office. The machinery, which was horse worked, was in a tower and, according to the description contained in the *Journal des Voyages de Monsieur de Conconys*, published in 1666, it consisted of four suction pumps in series worked by levers and rods moved by a cam wheel turned by the horses. The tower is shown in a contemporary plan of the district by Hollar. Ford's pumping engine was one of several which were erected on the Thames between Chelsea and Wapping in the seventeenth century.

PARTICULARS of America's longest railway tunnel were recently given in a *Daily Science News Bulletin* published by Science Service, Washington, D.C. The tunnel is on the Great Northern Railway, and pierces the Cascade Range of mountains about a hundred miles east of Seattle. Up to now, the longest railway tunnel in America was the Moffatt tunnel in Colorado, 6·11 miles long. The Cascade tunnel is 8 miles long, and is said to be exceeded in length by only the St. Gothard, Simplon, Loetschberg, and Mt. Cenis tunnels through the Alps. Another very long tunnel, however, is the Apennine Tunnel on the Apulian Aqueduct in southern Italy. This is about 9½ miles long. In constructing the Cascade tunnel, advantage was taken of the existence of a deep valley over the projected line, and from this a shaft more than 600 feet deep was sunk. From this shaft auxiliary tunnels were bored east and west, and these again were used to give access to several working faces in the main tunnel. By this means, progress was so rapid that the work was carried through in three years. The tunnel was open for traffic on Jan. 12, trains being worked through by powerful electric locomotives supplied with current at 11,000 volts.

ACCORDING to the Report of the Building Research Board for the year 1927 (London: H.M. Stationery Office; 3*s.* net), which has recently appeared, the staff of the Board at the end of the year was 111, and committees on weathering, on structures and on acoustics, assist the Board. The work in progress deals with weathering, building materials, cements, plasters, asphalts, with wind pressure and vibrations, and with heating, ventilation, and acoustics of buildings. The sulphuric acid from coal fires appears to be greatly responsible for weathering, and capillary effects for the decay of sandstone in the vicinity of limestone. Thermal stresses due to unequal temperature or to freezing cause spalling. Washing a surface at intervals and plastic repairs with oxychloride cement retard decay. The tests of structures show that their strength cannot be predicted from that of the bricks of which they are composed. Although results of such importance as these are being obtained and are made public by reports and by articles in the technical and the daily Press, the Board feels that full advantage is not being taken of the information by the industry. Closer co-operation between the Board and the industry is much to be desired.

THE nature of the work done by research associations does not as a rule lead to immediate and sensational achievements. It does, however, often lead to considerable improvements in manufacture and consequent reductions of price. To take a concrete case, the British Electrical and Allied Industries Research Association, which has just issued its eighth annual report, points out that its researches on cables have led to very appreciable economies being effected in the distribution of electrical energy. The consumer gets part of this saving as the price of supply is reduced. Similarly, the researches on the properties of steam which Prof. H. L. Callendar carried out for the Association will probably result in improvements in the manufacture of steam turbines, and again the public will get part of the benefit. The Association spent last year £25,000, of which the Government contributed £7200. This grant will rapidly diminish as the end of the second five years of the existence of the Association approaches, and it is necessary to take immediate action. At present the manufacturing section of the industry provides the larger part of the cost and eighty per cent of the personnel of the numerous technical committees. It has been pointed out that if every consumer of electrical energy contributed one farthing for each pound paid for electrical energy consumed, then the sum provided would pay for the whole annual cost of the researches of the Association, and the consumer would doubtless reap the benefit. We are afraid, however, the procedure underlying this suggestion could not be generalised and applied to researches in other directions. It would, therefore, even if it were equitable, be impossible to put directly into practice.

Two recent communications, one to the Manchester Literary and Philosophical Society, by Mr. H. Garnett, and another to the International Photographic Conference, have directed attention to the work of John Benjamin Dancer, one of that numerous class of scientific worthies whose names remain almost unknown, while their work is the property of all. Who, for example, knows that Dancer was the inventor of the porous earthen pot used in millions of 'wet' batteries? Who remembers that he devised the spring contact breaker or current interrupter originally applied to the induction coil, and still employed in almost the same form in every electric bell throughout the world? He was also the inventor of the minute photographs on glass which attracted attention at one time; he was one of the earliest workers on the form of photography introduced by Daguerre; and he experimented on the electro-deposition of copper. Another of his inventions was the binocular stereoscopic camera, the original example of which is preserved at Manchester and was described to the International Photographic Conference last summer. Like his father and grandfather, an optician by calling, Dancer made all the apparatus used by Joule in his classical experiments on the mechanical theory of heat. Born in London in 1812, he died in straitened circumstances in Manchester on Nov. 22, 1887, having for many years been blind.

THE Royal Cornwall Polytechnic Society was founded in 1833 at the suggestion of Miss Anna Maria Fox, its first purpose being to encourage a number of clever workmen who spent their spare time in constructing models and devising inventions. It set itself to provide technical education, and to encourage industry and ingenuity in a community distinguished for its mechanical skill, as well as to finance any invention likely to benefit local industries, particularly mining. The short history of the Society, which is included in the annual report for 1927, shows how the meetings became a recognised centre for the exhibition and demonstration of new inventions, some of which have become of world-wide renown and usefulness, such as Were Fox's dipping needle deflector, Nobel's nitro-glycerine, and Loam's man engine. Even more generally important have been the Society's educational efforts. Evening classes in mining subjects, a science school at Falmouth, and classes in connexion with South Kensington examinations, all owe their origin to its foresight and energy. The reports of 1927 and 1928 (vol. 6, pts. 1 and 2) show that the arts and crafts are still being encouraged by extensive prize schemes in connexion with the annual exhibition and special school work. In addition to their formal records, the reports also contain notes on eminent Cornishmen, and original articles on "Ancient Mining in Cornwall," French war prisoners in Cornwall, and the "China Clay Industry," as well as an address by Lord Gainford on "The Progress of Broadcasting."

Two articles of special biological interest in the December *Scientific Monthly* are Prof. Chas. G. Rogers' "Physiological Evidences of Evolution and Animal Relationship," and Prof. Theodore Korpányi's "Transplantation of Organs." In the former is discussed the possible evolutionary significance of the osmotic pressure of body fluids, their composition, and the relationship between their hydrogen ion concentration and that of sea-water; blood coagulation

and blood reactions; chemical actions and regulations in living bodies; excretion, reproduction, and death. The discussion suggests many physiological lines along which further investigation might well lead to biological conclusions of general importance. Prof. Korpányi's article describes the wonderful success which attended his efforts to transplant organs, such as amphibian and mammal eyes, the testis and spleen of amphibians, the spleen of rats, from their original connexions to entirely novel positions. Even amongst mammalia he has found that in its own proper situation a transplanted eye may regenerate the optic nerve and regain a power of vision.

THE Ossolinski Institute at Leopol (Lwow), in Polish Galicia, has recently celebrated its centenary. The founder died in 1826, his library arrived at Leopol in 1827. The Institute has been an irreducible bastion of Polish culture and intellectual life during a tragic century. The union of Polish learned societies in Leopol now presents a *Bulletin* (in French) describing their activities during 1925 and 1926. There are some thirty associated societies grouped in unions round the six Polish universities. Intellectual life is just emerging from war-time depressions. Books in Polish are a difficulty exaggerated by high costs of printing, import taxes on paper, lack of modern printing machinery, and the discouragement of publishers who find only a restricted market. The suggestion is made that publishers might agree not to publish competitive scientific books with similar contents, also to prepare a programme of educational text-books. Co-operation with foreign countries is welcomed; scientific publications have been sent to Tokyo and received from America, but on the whole it has proved easier to exchange periodicals than personal visits. Visitors to Poland will find the 94 pages of this *Bulletin* a useful vade-mecum as a guide to persons and institutions.

THE Registrar-General has issued the provisional figures of the birth- and death-rates and infantile mortality during 1928 for England and Wales. The birth- and death-rates are respectively 16·7 and 11·7 per 1000 population, and the infantile mortality is 65 deaths under one year per 1000 live births. The birth-rate is 0·1 per 1000 above that of 1927, and the death-rate is 0·6 per 1000 below that of 1927, and only 0·1 per 1000 above the lowest recorded (1923 and 1926). The infantile mortality-rate is the lowest on record, 4 per 1000 births below that of 1923.

DR. J. A. V. BUTLER, lecturer in physical chemistry in the University of Edinburgh, has been awarded the Meldola Medal of the Institute of Chemistry for his published work on the modern theory of conducting solutions. The Meldola Medal is awarded annually to the chemist whose published chemical work shows the most promise, and is brought to the notice of the administrators during the year ending Dec. 31, prior to the award. The recipient must be a British subject of not more than thirty years of age at the time of the completion of the work.

IT is announced in *Science* that Dr. Oliver Kamm, head of the department of chemical research of Parke, Davis and Company, formerly professor of organic chemistry in the University of Illinois, has been awarded the prize of 1000 dollars of the American Association for the Advancement of Science. The prize is awarded each year for a notable contribution to science presented at the annual meeting of the association and the associated scientific societies. Dr. Kamm's paper, presented before the section of chemistry at the recent New York meeting of the Association, was entitled "Hormones from the Pituitary Glands."

ACCORDING to the *Times* of Jan. 31, Signor Mussolini has presented to Switzerland a part of the scientific manuscripts of Albrecht von Haller, which were deposited at the Brera Library in Milan, and in the University of Pavia. Haller has sometimes been called the father of modern physiology. Born at Berne on Oct. 16, 1708, as a boy he acquired knowledge with ease, and as a man displayed immense industry and unusual versatility. His medical studies were prosecuted at Tübingen and at Leyden, where he came under the influence of Boerhaave. He practised for a time in his native town, and from 1736 until 1753 was professor of anatomy and botany at Göttingen. Returning to Berne, he there compiled his "Elementa Physiologiæ" and other works, took part in public affairs, and corresponded with eminent men in all parts of the world. He died at Berne on Dec. 12, 1777.

AT the recent annual meeting of the Botanical Society of America, held in New York City, the following were elected as Corresponding Members: Prof. C. H. M. Flahault, professor of botany in the University of Montpellier; Dr. D. H. Scott, lately honorary keeper of the Jodrell Laboratory, Royal Botanic Gardens, Kew; John I. Briquet, director of the Botanic Gardens, Geneva; and Alexander Zahlbruckner, director of the botanical section of the Natural History Museum, Vienna. The following were elected officers for the Society: *President*, Dr. Margaret C. Ferguson, Wellesley College; *Vice-President*, Dr. L. W. Sharp, Cornell University.

IN our issue of Aug. 18, 1928, p. 251, reference was made to a 'record' low barometric pressure of 665·1 mm. (886·8 millibars) during a typhoon. It should have been stated that the observation was made on Aug. 18, 1927.

THE *Leicester Museum, Art Gallery, and Library Bulletin*, a quarterly leaflet of about eight pages, is a useful means of keeping touch between the public and the institutions. The January number contains a select list of recent additions to the Library, but none of them, out of about a hundred serious volumes on science, art, and philosophy, deals with biological science. The special exhibition illustrating "Sport in the Midlands," from contemporary paintings, drawings, and prints of the last two centuries, proved to be a great success.

THE Ministry of Health has issued to sanitary authorities a *Circular* (No. 955) directing attention to the rapid spread of influenza reported from the United States and Canada, and bringing to the notice of local authorities the Memorandum on Influenza issued in 1927 (Memo. 2/Med.). This memorandum reviews the 1918–19 epidemic, discusses the bacteriology of the disease and mode of infection, and describes measures of personal protection and precautions when attacked, and outlines the action to be taken by sanitary authorities to combat influenza outbreaks. According to a recent *Daily Science News Bulletin*, issued by Science Service of Washington, D.C., more than a million cases of influenza occurred in the United States before Christmas, but the epidemic is now subsiding.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A county librarian under the Leicestershire County Council—The Director of Education, County Education Office, Leicester (Feb. 16). A live stock officer under the Ministry of Agriculture and Fisheries—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (Feb. 18). An assistant chemist under the Northern Coke Research Committee—Prof. Briscoe, Armstrong College, Newcastle-upon-Tyne (Feb. 18). A tutor for philosophy, politics, and economics at St. Hilda's College, Oxford—The Secretary, St. Hilda's College, Oxford (Feb. 23). A lecturer in pharmaceutics at the Chelsea School of Pharmacy—The Principal, Chelsea School of Pharmacy, Chelsea Polytechnic, S.W.3 (Feb. 25). A biologist, and a chemist, with experience of physiological problems, to assist in carrying out a survey of the Estuary of the River Tees—The Director, Marine Biological Laboratory, Plymouth (Feb. 28). A junior scientific officer under the Directorate of Scientific Research of the Air Ministry, primarily for research work in the aerodynamics department of the Royal Aircraft Establishment—The Chief Superintendent, R.A.E., South Farnborough, Hants (Mar. 2, quoting A.319). A head of the engineering department of the Technical Institute, Gillingham—R. L. Wills, Elm House, 15 New Road Avenue, Chatham (Mar. 9). An associate professorship of geography in the University of Sydney—The Agent-General for New South Wales, Australia House, Strand, W.C.2 (Mar. 16). A professor of philosophy in the University of Lucknow—The Registrar, The University, Lucknow, India (Mar. 17). A professor of medicine in the University of Lucknow—The Registrar, The University, Lucknow, India (Mar. 31). An assistant lecturer and demonstrator at the Leathersellers' Technical College—The Acting Principal, Leathersellers' Technical College, 176 Tower Bridge Road, S.E.1. Assistant directorships of a social survey—The Professor of Social Science, University, Liverpool. An entomologist for original research work into the bionomics of Tacchardia Lacca —"India," care of Richardson and Co., 26 King Street, St. James's, S.W.1.

Our Astronomical Column.

A CHART OF MERCURY.—M. E. M. Antoniadi published a chart of Mercury in *Comptes rendus* of the Paris Academy of Sciences in the autumn of 1927. This is reproduced, with a few additions resulting from his 1928 observations, with the 33-inch Meudon refractor, in the *B.A.A. Journal* for January 1929. Some of the markings, in particular those in the north-east quadrant, closely resemble those in Schiaparelli's chart, reproduced in *Ast. Nach.*, 2944 ; but the south-west quadrant is practically filled with a dusky shading ; the darker regions of this coincide with narrow dark markings drawn by Schiaparelli.

M. Antoniadi looks on the 88-day rotation, first announced by Schiaparelli, as completely established. He remarks that it has long been known that Japetus always turns one face to Saturn, this being proved by its notable variation of light in different regions of its orbit ; and as its distance from Saturn is 62 Saturn-radii, it was only to be expected that the sun, the density of which is twice that of Saturn, should produce a like effect on Mercury at a distance of 82 sun-radii. He considers that the axis of rotation of Mercury is not exactly perpendicular to the orbit plane, but does not indicate the amount or the direction of the deviation.

EPHEMERIDES OF VARIABLE STARS.—At the meeting of the International Astronomical Union at Rome in 1922, the Cracow Observatory was entrusted with the calculation and publication of ephemerides of variable stars. This task has been energetically fulfilled by Prof. T. Banachiewiez, and the seventh annual volume has just appeared. The descriptive matter is given in two languages, Polish and Peano's simplified Latin. The latter is easily read by any one with an elementary knowledge of Latin or the derived languages.

There is a useful index to the ephemerides and notes on certain stars. Use is made of three different time systems ; the Greenwich civil day (U.T.), the Julian day, and the new system proposed by the author, which begins at Greenwich midnight on Jan. 0, 1801. Tables are given to reduce from any of these systems to the others. The volume contains other useful tables, of precession, obliquity of ecliptic, moon's equation, etc.

THE BRIGHTNESS OF THE NEBULÆ.—*Ast. Nach.*, 5609, contains a paper by A. Markov of Pulkovo on the brightness of the spiral nebulæ. He has used both his own observations and those of many other observers, in particular Dr. Wirtz of Strasbourg. He concludes that the brightness of the spirals is far too high to be explained by reflection from the galaxy, as was suggested by Prof. Lindemann. He finds the surface brightness of the Andromeda nebula to be abnormally high, twelve times that of the average spiral, and seventy-six times that deduced for the galaxy ; the latter, according to its surface brightness, though not according to its size, is to be ranked among the faint spirals. The star-density in the Andromeda nebula is concluded to be unusually great, and confirmation of this is drawn from the large number of novæ that have appeared in it. Its central brightness (measured from a square 1″ in the side) is given as 17 mag., falling to 21 mag. at a distance of 5′ along the minor axis. The Pulkovo results give the value $+0{\cdot}68$ mag. for the average colour index of the spirals.

The paper also deals with gaseous nebulæ ; the photographic brightness of some of them was found to be lower than the visual brightness. Their brightness as a whole is stated to be of the same order as that of the gas in an exhausted tube under the influence of soft cathode rays.

Research Items.

MARRIAGE IN AFRICA.—In *Man* for January, Mr. E. Torday examines critically the terms in use in relation to the consideration which passes between the contracting parties among African peoples at the time of marriage. It is now almost universally admitted that marriage does not consist of a purchase. Among the Amazulu, for example, the bride remains a member of her clan, and the contract may be sealed by a mere trifle, such as a hoe or basket of corn as well as by many head of cattle. Among the Natal Kaffirs the amount was fixed by disinterested parties. The natives themselves repudiate the idea of a sale, and on the Congo the Boloki regarded the gifts of food and sugar-cane wine as proof that the woman was not 'sold as a slave,' but 'given as a free woman.' As a matter of fact it is among those peoples where the bride-price is not given that marriage is most irrevocable. 'Bride-price' is therefore absurd, and 'dower' and 'settlement' are not more appropriate, as these terms should be reserved for customs which really belong to these classes, such as the hoes which a girl received from her father among the Chaga at circumcision and takes with her on her marriage, and the settlements of cattle made by the Bamangwato father to serve his daughter during her marriage and in case of widowhood. The use of specific native terms is to be deprecated, as notwithstanding their obvious accuracy they lead to confusion and the exact implication is not clear to the ordinary individual. The sealing of the contract is the act of paramount importance. It takes place between groups and not individuals, and each group pledges itself to see to the carrying out of the contract. Hence if the wife fail, the group supplies her place by offering a sister or other equivalent and thus recognises its obligation to continue the performance of the contract. Further, the consideration, whatever it may be, may be divided among the members of the bride's clan or group. Tentatively, 'earnest' is suggested for discussion, as implying the undertaking to ensure the due observance of the contract.

HARAPPA IN THE VEDAS.—The early culture discovered at Harappa in the Punjab and Mohenjo-Daro in the Indus Valley up to the present has been regarded as of non-Vedic type, and it has been stated that there is no indication that the builders of these cities were akin to the Rig-Vedic Aryas. Sir John Marshall thinks the most reasonable view is that they were the pre-Aryan (probably Dravidian) people known in the Vedas as the Dasyus or Asuras, whose culture was destroyed in the second or third millenium B.C. by the invading Aryans. In the *Indian Antiquary* for January, Binode Behari Ray Vedaratna puts forward a claim that these relics belong to the Aryan civilisation. In ancient times, when the Aryans inhabited the Sapta-Sindhu region and the Punjab, perhaps they erected two cities on the god-made land —the alluvial land on the bed of the Sindhu-Samudra. There was in Vedic times a city named Hariyupia, where a battle was fought between King Abhyavarti and Varashikha's sons in which, Indra fighting on the side of the former, the latter were defeated and slain. Another battle was fought between Kavi, brother of Abhyavarti and the Aryan invader Sudas in which, again through the aid of Indra, Kavi was defeated and slain. This battle was fought near the river Parushi (Râvi). If the city Hariyupia was on the bank of the river, it may be Harappa which is on the eastern side of the Râvi. Abhyavarti and Kavi appear, therefore, as kings of Harappa who fought against the invader. Sudas was contemporary with King Trasadasyu, who reigned in the fifth millenium. Abhyavarti was an emperor from whom Bharadvaja Rishi received offerings of cows and other things. It may therefore be concluded that he was an Arya of the Prithu dynasty, who lived in the fifth millenium, and that at that period Harappa was the capital of an Arya emperor and was not non-Aryan.

'FUNNEL-MOUTHED' TADPOLES.—The function of the 'funnel' mouth of certain *Megalophrys* tadpoles has been for some time a subject for investigation. Dr. Sunder Lal Hora, in his latest communication ("Further Observations on the Oral Apparatus of the Tadpoles of the genus *Megalophrys*." *Records of the Indian Museum*, vol. 30, pt. 1, 1928), describes the results of his most recent researches into the habits of these interesting larvæ. The tadpoles of *Megalophrys parva* are abundant in shallow, swiftly running streams, and are to be found in the sheltered parts of these where they have not to contend against the torrential currents which are liable to carry them away. In such situations they do not hang from the surface film and feed as they may do in quiet waters, the oral apparatus enabling them to feed at any level, even at the bottom, and the funnel when folded helping by excluding large, and probably facilitating the entry of small, particles in flowing waters. Whilst this oral apparatus helps to make the anterior end buoyant, the developing lungs distended with bubbles of air apparently act as hydrostatic organs and enable the animal to suspend itself at any particular level, making the whole body buoyant—a distinct advantage when it is carried away by a flood. Living thus in hill streams which are liable to break up into a series of pools and puddles, dry up altogether, or become rapid torrents generated by a single shower, the tadpoles, according to Dr. Hora, have adapted themselves to such variable conditions and evolved the funnel mouth and hydrostatic lungs.

SELECTIVE FACTORS IN SALMON MIGRATION.—In spite of the attention given in recent years to the influences which determine a salmon's selection of a particular river for spawning purposes, the subject is still very obscure. It is clear enough that the responses to some sort of stimulus are very specific, for not only do salmon in Great Britain often return to that very river from which they set out, but also in Canada it has been found that distinct races of salmon occur in definite tributaries in the same river system, so that even selection of tributaries must be made. Dr. R. E. Foerster's observations on the migration of sockeye salmon in the Cultus Lake area of the Fraser River bear on the relations of temperature, hydrogen ion concentration, and oxygen to the up-stream movement (*Canadian Field-Naturalist*, January 1929). He found that while one race of sockeye salmon may, at the junction of two streams, select the colder, another may prefer the warmer; and that the same race may at one point ascend the colder and at another the warmer of the alternatives. Temperature, therefore, cannot be a prominent directing influence. As a rule the migrating salmon preferred a water with somewhat lower hydrogen ion concentration, and yet they avoided the waters of Sumas Creek, always lower in this factor than Sumas River. Indeed, the conclusion seems to be that neither temperature, hydrogen ion concentration, nor oxygen content can be regarded as simple factors by which selection is determined, although it is reasonable to suppose that some physico-chemical attribute or attributes of the waters traversed, either singly or in association, direct the route of migration.

INDIAN DEEP-SEA SPONGES.—In his "Report on Some Deep-Sea Sponges from the Indian Museum collected by the R.I.M.S. *Investigator*, Part 2, Tetraxonida (concluded) and Euceratosa" (*Records of the Indian Museum*, vol. 30, pt. 1, 1928), Mr. Burton continues his study of deep-sea sponges. These are of great interest. Two specimens of *Biemna annexa* (Schmidt) were found, hitherto only recorded from the North Atlantic. The diagnosis of *Sceptrospongia coronata* is based on a partial description by Dendy given in relation to his study of the origin and growth of sponge spicules. These spicules are highly elaborate, as was shown by Dendy, who directed attention to their variable character, and the figures given in the present paper show the many different forms present in the one sponge. The genus *Bubaris* is revised, the author removing five species to other genera and retaining thirteen, including three new species. These deep-sea sponges form a remarkable and valuable collection. The paper is well illustrated by text figures and two photographic plates.

AUSTRALASIAN MOLE-CRICKETS.—In the *Records of the South Australian Museum*, vol. 4, No. 1 (1928), Mr. Norman B. Tindall reviews the Australasian species of Gryllotalpidæ, which have been much neglected by recent workers. He defines these insects as crickets of subterranean and aquatic habits, with the anterior legs adapted for burrowing and the ovipositor obsolete in the females. All the members are water-loving, frequenting light soils and sandy ground where there is ready access to moisture, but it would seem that the term aquatic is not strictly applicable. It is generally assumed that only male mole-crickets are capable of sound-production, but an examination of any of the females of the Australian species of *Gryllotalpa* will show an apparatus on the under side of the elytra, with which individuals are capable of making themselves heard. Several species are of economic importance on account of their underground burrowings, which injure certain root crops, besides helping to crumble the banks of water channels and dykes. A matter of considerable interest is the recent importation of the Surinam toad (*Bufo agua*) from Porto Rico into Barbados for the purpose of destroying the mole-cricket *Scapteriscus vicinus*. Mr. Tindall's paper is admirably illustrated and forms a useful contribution to Australian entomology.

SIBERIAN METEOROLOGY.—The Vladivostok Observatory, now designated the Geophysical Observatory of the Far East, has resumed publication of the meteorological observations from eastern Siberia. Two parts of the *Annales de l'Observatoire central* give respectively the figures for 1916 and 1917, thus continuing the series that have already appeared. The Director announces that it is hoped to publish succeeding years' work shortly and then to resume annual publication. The records come from about a hundred stations in the Amur and coast regions, Kamchatka, Sakhalin, and so far north as Anadir. Monthly means are given for temperature, vapour tension, humidity, cloud and wind for the seventh, thirteenth, and twenty-first of the months. Pressure, maximum and minimum temperatures, precipitation, and other data are also given. Although there are gaps in some of the stations records, the observations are remarkably full and detailed. The text is in Russian but headings are given also in French.

ENVIRONMENTAL FACTORS OF PHILIPPINE BEACHES.—Mr. Raymond Kienholz, in his paper "Environmental Factors of Philippine Beaches, with Particular Reference to the Beach at Puerto Galera, Mindoro" (*Philippine Journal of Science*, June 1928), records various climatic observations with regard to temperature and rainfall; and relative humidity, evaporation, wind, sunshine, and soil on a sandy beach, rocky headland, and mangrove swamp. The author in a former communication (*Proc. Am. Phil. Soc.*, **65**, No. 5 Supplement; 1926) has discussed the effect of these factors upon the vegetation, especially with regard to the leaf. The climate of the Philippines is essentially tropical. The temperature is very uniform, with only slight seasonal and daily fluctuations, and the rainfall is extremely variable, but there being no dry season at Puerto Galera enables many plants to grow on the beaches all the year round, which are limited to the wetter months in other parts of the islands. The relative humidity is usually high. The amount of evaporation measured by means of standardised Livingston atmometers is highest at the rocky headland, lowest underneath the mangroves. The rate of evaporation is closely correlated with the amount of wind, and the high evaporation rate in spite of the fairly high humidity is probably the reason for certain structural adaptations of the leaf for conserving its water supply.

GEOLOGY OF BRITISH HONDURAS.—Between 1921 and 1926, Mr. Leslie H. Ower was actively engaged in a geological investigation of the only British possession on the mainland of Central America. As the territory has hitherto been very little known, a sketch of the geology from Mr. Ower in the *Jour. Geol.*, pp. 494-509; 1928, is particularly welcome. British Honduras consists of a central peneplain of folded Upper Carboniferous marine beds, with granite intrusions, surrounded by unfolded limestone of about Oligocene age. Deposits of ages between these two periods are unfortunately unknown. The main movements can be referred to Permo-carboniferous and Miocene diastrophism. The trends of the Palæozoic rocks conform to those of Honduras and Guatemala, all following a series of generally east-west folds that arose out of the Honduranian geosyncline. Granite intrusions follow the crests of the folds. Much more youthful north-east to south-west features are common, these being parallel to the trends of western Cuba. The east coast is determined by large faults which descend rapidly into 2000-fathom water. It is noteworthy that British Honduras suffered no folding during the building of the Central American mountain system. This began in the Miocene, and is apparently still active. British Honduras, however, is outside the severe earthquake zone of the present day.

MINE VENTILATION.—The Engineering Experiment Station of the University of Illinois is continuing its experiments upon mine ventilation, and has just issued in *Bulletin* 184 the third part of a paper upon the measurement of air quantities and energy losses in mine entries, by Messrs. A. C. Callen and C. M. Smith. This *Bulletin* refers wholly to measurements of air (and the calculations based thereupon) carried out at one of the mines of the Peabody Coal Company. The investigation has been done with great care, and a number of interesting results have been obtained and recorded, but it is very doubtful whether these can be of any general application, seeing that they depend entirely upon the special conditions obtaining at this particular mine and do not allow of any general deductions from them.

THE ISOTOPES OF NEON.—In a paper which appeared in the *Philosophical Magazine* in 1920, Dr. F. W. Aston mentioned that neon appeared to possess a third isotope, of atomic mass 21, in addition to its two well-established components of masses 20 and

22, but he made no reference to this in his Bakerian lecture in 1927. T. R. Hogness and H. W. Kvalnes, who have been using the same gas to calibrate another form of mass-spectrograph, now report that a peak corresponding to a singly charged ion of mass 21 invariably appears on their curves, and since they find no trace of a peak for an ion of mass 23 which could be attributed to a hydride of Ne^{22}, this cannot be due to a hydride of Ne^{20}, and is therefore ascribed by them to the third isotope of neon. Their measurements, which have been published in the December number of the *Physical Review*, show that Ne^{21} atoms are rare, constituting only about the fiftieth part of ordinary neon, and they suggest that Dr. Aston did not detect them in his later work because the high resolution of his apparatus had been partly attained at the expense of its sensitivity.

THE DIFFRACTION OF ELECTRONS BY MICA.—A number of cathode ray diffraction photographs are published by S. Kikuchi in the June issue of the *Proceedings of the Imperial Academy of Japan*. They were obtained with mica in an apparatus similar to that used by Prof. G. P. Thomson, and were primarily designed to show the electron analogue of the Laue phenomena for a crystalline plate, but actually proved to be more complicated. Very thin sheets of mica were found to produce an equilateral pattern built up of lines intersecting at sixty degrees, with enhanced spots at the angular points, whilst thicker sheets gave both Laue spots, diffraction circles, and sets of bright and dark lines with a unit angular spacing of thirty degrees. The author has not attempted to account for all these effects in detail, although they are evidently in general agreement with the requirements of the wave mechanics, but he points out that the circles are apparently formed as the result of diffraction of the electron waves by a linear array of atoms, and that absence of this type of interaction in the case of X-rays may indicate the existence of a fundamental difference between light waves and material waves.

CUTTING OILS.—In a lecture on cutting and quenching oils delivered by Mr. C. H. Hudson to the Junior Institution of Engineers on Dec. 21, the functions of a cutting oil were defined as: (1) to lubricate the chip over and along the lip of the cutting tool and so lengthen the latter's life; (2) to disperse as rapidly as possible the heat generated by cutting; and (3) to wash away the chips, keep the work clean and prevent clogging of the machine by the accumulation of swarf. In the case of soluble oils, it is essential that there should be no free acids which, if present, would cause corrosion, nor are oils made from a rosin base desirable as they tend to cause gumming of the moving parts of the machine tools on which they are used. The use of a lard or lard substitute cutting oil was advocated on automatic lathes and other machine tools where long tool life and working to very close limits is essential. It was emphasised that the lowest priced soluble oil is not always the most economical, as the cheaper grades will not bear the same dilution and give as good results as a higher grade oil; the latter can be diluted in the proportion of 30 to 1 and the former 20 to 1, which shews a saving of one farthing per gallon in favour of the more expensive solution. For operations on some special metals and other substances special lubricants and cooling agents are used, such as paraffin for soft aluminium alloys, or turpentine, in glass boring and shaping. In some works lard oil and white lead mixed to a gummy consistency is used when reaming and tapping high carbon and alloy steels. In the United States compressed air is used as a cooling fluid in some operations with notable success, for example, in the milling and drilling (usually done dry) of cast iron. The air absorbs the heat generated without producing the glazing effect which takes place if an oil is used. In connexion with methods of distributing oils to the cutting tools, a large flow of oil at comparatively low pressure is far better than a small flow at high pressure.

COOLING LARGE TRANSFORMERS.—During the last few years, the size of the transformers used for converting high-pressure alternating current into low-pressure alternating current has been continually increasing. According to *A. E. G. Progress* for November, several units having an individual output of 60,000 kilovolt amperes (kva.) at 220,000 volts are now in course of construction. In the A.E.G. (Allgemeine Elektricitäts Gesellschaft) works, a transformer with an output of 100,000 kilowatts is used for testing purposes. If we assume that the power lost at full load is only one per cent, the heat generated in the transformer itself would be equal to that developed by 500 electric fires all on at once. It will be seen, therefore, that very special methods have to be adopted for cooling it. Since the heat losses in a transformer increase very approximately as the cube of the linear dimensions, and the cooling surface increases only as the square of the linear dimensions, the difficulty of the cooling problem increases rapidly with the size of the transformer, provided that the cost is to remain proportional to the output. For transformers immersed in oil contained in a corrugated iron tank, self-cooling can be used up to outputs of about 5000 kva. The cooling is sometimes accelerated by forcing draughts of air along the sides of the tank. Another system frequently used is to have pipes through which water is kept circulating immersed in the upper portion of the oil. The quantity of water required per hour for a 10,000 kva. transformer having an efficiency of 99 per cent is nearly 2000 gallons, the temperature of the oil being maintained at about 100° F. The A.E.G., instead of forcing the water through the pipes, now draws it through by a suction process. In this case if the pipe springs a leak the only thing that happens is that the oil enters the water and not vice versa, which would ruin the insulating power and the electric strength of the oil. Details of many other interesting methods are given.

STRUCTURE OF ETHYLENE.—The November issue of the *Indian Journal of Physics*, which is largely devoted to measurements of the physical constants of organic substances, contains a paper by V. I. Vaidyanathan on the magnetic properties of ethylene. In spite of the simplicity and importance of this compound, no determination of its susceptibility appears to have been made since Quincke reported it to be feebly paramagnetic. From its constitution it should be diamagnetic, which has now been shown to be the case, the value of the molecular susceptibility ($1 \cdot 5 \times 10^{-5}$) being close to that calculated from Pascal's additive law ($1 \cdot 8 \times 10^{-5}$). It is also at least a remarkable coincidence that the molecular susceptibility of ethylene is almost identical with the atomic susceptibility of sulphur. The two substances have sixteen electrons to the molecule and atom respectively, and this result might be regarded as confirming the view, which is now fundamental in the quantum theory of molecules, that the properties of a molecule are intimately connected with those of an atom with the same number of electrons. The author has not been able to come to any definite conclusion as to the structure of ethylene, but he has pointed out that it probably contains only four electrons which are moving in large orbits, and that on this assumption the value of the effective molecular radius deduced from the susceptibility (1 A.) is in reasonable accord with that obtained from the viscosity of the gas.

The Grid Transmission Scheme in Great Britain.

THE Electricity Act of 1926 authorised the creation of the Central Electricity Board. To this Board was entrusted the work of constructing all the transmission lines required for interconnecting the power stations selected for supplying the national requirements for electrical energy. It had also to supply energy to undertakings which had no power stations. In a paper which was read before the Institution of Electrical Engineers on Jan. 24, Messrs. Johnstone Wright and C. W. Marshall described what has already been done and gave an outline of the projected scheme.

It has to be remembered that although British engineers knew how similar schemes had worked on the Continent and in America, yet they have developed on somewhat different lines in these countries, and it is no easy matter to say which is the best. In Great Britain the sources of energy are not only comparatively close together but they are also close to their consumers. In this case the main function of the transmission line is to allow the generating plant only to operate at its most efficient load, and at the same time to reduce to a minimum the requisite stand-by plant. This has been done to a limited extent by existing power stations. The novelty of the grid scheme lies in the high voltage employed for this purpose and the magnitude of its operations.

The system of supply adopted is three phase, and the pressure of supply between any pair of wires is 132,000 volts. The standard frequency of 50 is adopted. To illustrate the comparative smallness of the British system, a map of the British Isles is shown superimposed on the area of a single large interconnected system in the United States and is nearly covered by it. With the exception of Italy, the systems of supply adopted in Europe are very similar. The pressures in France vary between 110 and 150 kilovolts. The majority of German lines work at 110 kv., but there are lines in course of construction which will work either at 220 kv. or 380 kv. The Spanish scheme is an interesting one, as it provides for a 220 kv. ring main with feeders and distributors at 110 kv. High tension lines already stretch along the north of Spain from Barcelona to the north of Portugal. Lines operating at 132 kv. are very extensively used in America and these systems are continually being extended. The length of the lines operated at this voltage in America is 3824 miles. The complete British system will comprise 2600 miles of circuit, the wires being suspended overhead.

The wires are designed so that whatever the load the variation from the normal voltage will not exceed ± 5 per cent. The choice of the metal to be used for the conductors was determined largely by its mechanical properties. The difficulties in getting way-leaves and tower sites made it essential to use spans of the maximum permissible length. The selection of steel-cored aluminium conductors gives general satisfaction. In the case of a flash-over the steel core prevents the conductor from being burned out. So long as the aluminium remains sound, the steel core is protected from the atmosphere. The life of the aluminium therefore determines the life of the cable. Tests show that this life is at least twenty-five years. The standard conductor consists of a central core of 7 strands of galvanised steel wire surrounded by two layers containing 12 and 18 strands respectively of aluminium wires. Every strand is 0·11 inch in diameter, and the conductivity of the conductor is equivalent to that of a copper conductor 0·175 square inch in sectional area, and its normal current carrying capacity is 219 amperes. The size of the conductor being much greater than if it were of copper, brush discharges do not ensue until under normal atmospheric conditions the voltage attains 184 kv. At less voltages the loss due to brush discharges is negligibly small.

The towers used in various countries to support the wires are of very different designs. Steel, reinforced concrete, and even wood have been used in their construction. In the choice of broad-base towers made of steel for the grid, æsthetic considerations played a considerable part. The choice of broad-base or narrow-base towers was generally determined by way-leave considerations. The double-circuit towers are 18 ft. 6 in. at the base and 78 ft. high.

The conductors are supported by strings of insulators, generally nine in number, the working load on which is 4000 lb. These chains are subjected to very rigorous, mechanical, electrical, porosity, and thermal tests. A temperature-cycle test is made on each unit by immersing it in water at 93° C. for an hour, and then immediately plunging it into a mixture of ice and water. The voltage distribution test consists in determining the fraction of the total voltage that is borne by each individual unit of the chain.

The most difficult problem the engineers had to solve was to devise an efficient protective system for the grid, and for solving this not much help could be obtained either from American or Continental practice. Owing to the high voltage and the consequent wide space between neighbouring lines, there is not much risk of trouble from birds and branches of trees. Possibly also the wide spacing diminishes the risk of trouble from atmospheric discharges. The solution adopted is to depend on earthing the system by means of a high-conductivity earth wire and to use 'arcing' rings for the insulators. The authors state that 'the earth wire serves the double purpose of acting as a definite return for fault currents, and as an electrostatic screen to reduce voltages induced by lightning.' They are going to use no 'lightning arrestors,' at least in the first instance. In their opinion the comparatively few thunderstorms which occur in Great Britain do not justify the use of these protective devices.

It appears that in the grid the neutral points of the transformers, etc., will be directly connected with the earth. It is anticipated that the excess current relay will trip the line when an atmospheric discharge takes place, and so the arc will be suppressed and no serious interference with the supply will ensue. According, however, to *A.E.G. Progress* for December 1928, practical experience does not bear out this anticipation. It is known that momentary shocks are sufficient to throw extensive networks out of step, especially when working near their critical load. The German engineers operate with insulated neutral and use the system of coils invented by Prof. Petersen to suppress the arc. This system has been in operation for ten years, and on the Continent the number of networks adopting it is continually increasing. The 100 kv. network supplying South Germany, and owned by the Rhine Westphalian Electricity Company, is now adopting this system exclusively. The entire new 220 kv. system of this Company will be equipped with Petersen coils. In our opinion the reasons advanced in favour of the Petersen coils by the engineers of the Allgemeine - Elektricitàts - Gesellschaft should be seriously considered.

The question of inductive interference between power lines and communication lines has been discussed by the International Consultative Committee, and a résumé of its results is given in the paper.

We are glad that the danger from electrostatic induction is recognised. Danger exists from electrostatic induction for a distance of about 400 yards on each side of the 132 kv. lines. The maximum allowable pressure induced in a communication line has been fixed by the I. C. C. as 300 volts. Formulæ are given by the I. C. C. to enable the induced electromotive force to be computed. They are given in terms of Bessel's functions, but as these functions are written in the form J (x, y) and are apparently functions of two variables, we fail to understand what they mean. It is stated with great emphasis that it has been definitely decided that, from the point of view of interference with communication circuits, the earthed neutral system is better than the insulated neutral system. There is nothing new in the statement that the resistivity of the matter forming the earth's surface is a predominant feature in determining the induced voltage. This was known many years ago. As a matter of fact the electrical resistivity of the surface ground varies from day to day.

The problems that will arise in connexion with this huge network of overhead wires have hitherto received little consideration. Its capacity to earth cannot be neglected, as it is very large. If it were insulated at every point, then if it sparked to earth the high pressure behind the spark would maintain a continuous arc the current in which might easily be hundreds of amperes. In the Bayernwerk network in south Germany (1250 miles of overhead wires) the capacity current in the arc has been computed to be between 500 and 600 amperes. It is stated, however, in *A. E. G. Progress* that the Petersen coils suppress the arcing flame at the faulty point almost instantaneously.

Standard substations of six types have been adopted. The minimum spacing between conductors of different phases is nine feet. All the transformers are designed for outdoor working. If their capacity exceeds 30,000 kva., then owing to the difficulties of transport they are made up of three single-phase units star connected. They are all provided with voltage-regulating equipment. Transport considerations made it necessary to use extremely strong tanks, as each transformer has to be capable of being transported completely immersed in oil by rail, road, and sea.

In the Scottish system the River Forth is crossed near Kincardine by a span 3050 feet in length. The suspension towers are each 338 feet high and the high-water clearance is 158 feet. The span is anchored at each end on 60-foot towers. Double chains of suspension insulator units are used. Each chain consists of 11 insulators. The total working stress is 20,000 lb.

An excellent map is given of the projected scheme of high-tension transmission lines for Great Britain. The Scotch scheme, which is nearest completion, shows that Carlisle, Edinburgh, and Glasgow will all be connected by a ring main. There are four large hydroelectric stations between Dundee and Inverness. The concentration of large stations on the Clyde is noticeable. Between Liverpool, Manchester, Leeds, and Sheffield there are many large power stations, and similarly round Birmingham and in London. Cambridge will be in direct connexion with Lincoln and London. Along the south coast of England the transmission lines will extend from Plymouth to Folkestone through Southampton. From Southampton they will extend to Bristol, Worcester, Cardiff, and South Wales. In North Wales there are several large hydroelectric generating stations, but these are not in connexion with the grid.

A few tables of the constructional costs for Scotland are given. For normal lines the costs of the lattice towers account for nearly half the total costs. The costs of the conductors are 30 per cent, and of the insulators 11 per cent of the total. The costs of the large high-tension transformers used average about 14 shillings per kilovolt ampere at 10,000 kva. size to about 5 shillings per kva. at 60,000 kva. size. The price of a small substation equipment averaged about £20,000. For larger substations the cost was about twice as much.

Structure of the Stars.

ON Friday, Feb. 1, Prof. A. S. Eddington delivered the fifteenth Thomas Hawksley lecture before the Institution of Mechanical Engineers, on "Engineering Principles in the Machinery of the Stars." In introducing a general account of his well-known theory of the internal constitution of the stars, Prof. Eddington remarked that although modern physics is tending to show that engineering principles are not fundamental in the constitution of the universe, yet Nature does contrive to produce engineering work on the grand scale, much of which is exemplified in the structure of the stars. He then proceeded to amplify this statement by regarding a star as a power station, and considering the questions of its equipment and fuel supply.

The latter question is still in a very unsettled state, and although there are strong grounds for accepting provisionally the hypothesis that a star's heat is provided by the destruction of matter inside it, there are some observational results which are hard to reconcile with this. The lecture was framed in characteristic language, embodying Prof. Eddington's customary charm of expression. A typical example is the following statement of the somewhat recondite 'exclusion principle' of modern atomic physics:

"In general terms it means that every electron insists on being in some way a little bit different from its neighbours. So when pressure tries to insist on electron A packing a little closer to electron B, A replies 'No. We are already so nearly in the same position that people can only just manage to tell us apart.' But it is open to persuasion by an offer of some other distinction as a substitute for difference of position. If A differs sufficiently from B in energy or in momentum, that will do just as well. So at high temperatures when there is plenty of energy to go round, the electrons can distinguish themselves by seizing different quantities of it, and then they will not mind losing their distinction by position. Poor things! they are all turned out exactly to pattern by Nature's lathe, so they treasure these ways of insisting on their individuality—not to be just like one's neighbour. And so it comes about that at low temperatures the exclusion principle devotes its efforts to separating the electric charges in position and gives a large effective volume to the atom, whereas at stellar temperatures it is more concerned with distinguishing their momenta and energies, and is lax about keeping them apart in position."

Prof. Eddington referred to the possibility that a star might be regarded as being in "a rather remarkable state, namely, a crystalline gas." He does not think the gas inside a star is crystalline, but that it is not so far removed from that condition that we can leave the possibility out of all consideration. In any volume inside a star there are a few big positive charges (atomic nuclei) and a relatively much larger number of small negative charges (electrons). The former tend to take up a configuration of minimum energy, which is that of a crystal lattice, while the

latter spread fairly uniformly over the volume. The energy of agitation tends to stir the material and 'melt' the crystal, but the crystalline state is a fair approximation to the actual condition. The gaseous character of the material would be manifested chiefly in its mechanical properties of expansion and compressibility, while the crystalline structure would appear chiefly in the optical properties.

A discussion of Cepheid variables regarded as pulsating stars occupied a considerable portion of the lecture. Although the difficulties of the conception have not been completely overcome, Prof. Eddington regards them as by no means serious. The problems set by such stars have led him to the view that the influence of temperature and density on the rate of liberation of sub-atomic energy must be an indirect one. "The energy is released from certain active substances formed inside the star; the rate of formation of these substances increases with temperature and density, but they break up and liberate the energy at a rate unaffected by temperature and density."

Museums and Education.

SIR HENRY A. MIERS accomplished a great work for the museums of Great Britain when he wrote his report for the Carnegie Trustees, but that report was designed more particularly for museum committees and museum curators, and its appeal was for the specialist rather than the public. Now Sir Henry adds a second to his former accomplishment, for he has gone out into the wilderness to preach the gospel of museums to the people. This is as it should be, for it is to the apathy of the public and the dislike of intellectual effort, observable even where first-rate museums offer no excuse for it, that much of the inefficiency of museums can be traced.

On Jan. 23, Sir Henry Miers delivered an address on "Museums and Education" to the Royal Society of Arts, when the Right Hon. The Earl of Crawford and Balcarres, himself known for his wide interests in museums, was in the chair. Readers familiar with the strictures of the report will be prepared to learn that his address was not a gospel out and out, but underlying the very just criticisms which he made of certain types of museums, of curators, and of the public, lay a deep current of optimism in the educational possibilities of museums, and in a rejuvenated future in which they would take their due place in the development of the nation's outlook and thought. His address fell into two broad sections: in the first, he displayed the weaknesses and inefficiencies of many museums as they now exist, and showed how these had a direct and unfavourable repercussion upon the people's museum outlook. In the second, he pointed the way in which steady improvement might be made, by a reorganisation of museums towards special ends.

Sir Henry Miers' general criticisms of local museums as they are are familiar to readers of NATURE. He summed them up in the course of his lecture: "There are many signs of improvement in the general situation, but, when all is said, it must be confessed that the large majority suffer from over-exhibition, lack of policy, and the fatal habit of accepting miscellaneous gifts, so that of the service which they might render throughout the country a very small part is actually fulfilled by them."

Perhaps it is more profitable to dwell on Sir Henry's constructive suggestions. He founded his proposals on the proper assumption that museums are designed for the use of four distinct categories of visitors: the ordinary, more or less casual, visitor; the local student, whether he be of ripe years or an elementary scholar; the definite and purposeful collector and inquirer; and the scientific research worker. Not every museum can cater for each of these groups, but the principle of appeal for any group ought to be similar wherever it has a place. Thus it is most fitting that for the ordinary visitor the nature and resources of the town or district should be displayed, the labelling should be thorough yet simple in word, and easy transitions should lead from one collection to another of different kind.

For school children and older scholars, summary collections or introductory series are desirable, and Sir Henry said a true word when he stated that the writing of lucid, accurate, and short labels is a very difficult task, requiring much care and thought, and, we would add, experience. For the collector, the introductory series must be supplemented by systematic collections, and for the research worker, to these must be added great stores of classified and authenticated material.

A strong appeal was made for the strengthening of the Museums Association, as a correlating body, for the extension of interaction and inter-lending between the national and local museums, and for the creation of a type of museum new to Great Britain, the 'folk museum,' which would depict in complete units the life of English (why not British?) people through the ages.

Culture Sequence in the Swiss Lake Dwellings.

OWING to lack of supervision and organisation in the earlier explorations of the Swiss lake dwellings, chronological data relating to the finds are scant. As, however, investigations were for the most part of a superficial character, many sites were left undisturbed except for the topmost layer. Some of these have now been explored by M. Vouga under the auspices of the Neuchâtel Committee for Archæological Research. A summary of the results is given in *Antiquity* for December.

The civilisation of the Swiss lake dwellings up to and including the Copper Age is represented by two phases. The older appears in a single stratum, while the second consists of two or three superimposed. These are distinguished as lower, middle, and upper Neolithic and Eneolithic ages. They are separated each from each by a barren layer of a certain thickness. It is to be noted that in the deposit of the first occupation, which always rests on the lacustrine bed, the objects found are for the most part of a much more advanced technique than those found in the upper layers. This is particularly true of the pottery, which reaches a high grade of excellence. Here, too, the flint is dark brown, semi-transparent at the edges, and not the opaque white, dusky, or black local product. The spindle-whorl seems unknown.

The middle Neolithic has been called the *bel âge de la pierre*, but that appellation must now be abandoned in view of the finds in the hitherto neglected lower Neolithic. It is, however, still the most important settlement, its deposit sometimes being a metre thick. The remains of the habitations have generally been destroyed by fire. Its flint work is richer and more varied than in the early stratum, the 'type-fossil' being the arrow-head. The pottery has degenerated, and gives the impression of an art in its infancy.

The upper Neolithic is a normal evolution of the middle, of which it represents merely an advanced

phase, though separated from it by a barren deposit. As a rule it forms the base of the archæological deposit of the Copper Age, which is found inland, proving that the waters stood at a higher level in the late Neolithic period.

The Eneolithic age evolves normally from the preceding Neolithic. The fact that the upper strata of this period were disturbed at a very early date points to the cultivation of the ground by the succeeding people of the Bronze Age. The occurrence of the Bronze Age dwellings at a greater distance than the Neolithic from the present shore points to a period of drought rather than to greater technical skill.

University and Educational Intelligence.

Birmingham.—The report of the Vice-Chancellor to the Council for the year 1927–28, which will be presented to the Court of Governors at the annual meeting on Feb. 21, has been issued. The number of students for the session showed an increase on that for the preceding year, and a further increase appears in the present session. Pleas are advanced for the extension of the residential accommodation for women students, for an increase in expenditure on the library, and for more scholarships with which maintenance grants must be associated. The appointment of some senior members of the non-professorial staff to Grade I. is urged on the ground that, if retirement at the age of sixty is compulsory, those who have not held for some ten years a post with a salary of not less than £600 are entitled only to a pension which is quite inadequate to services rendered. The Vice-Chancellor reports that the voluntary medical examination of women students on entering the University, which was instituted two years ago, has met with complete success, and it is hoped that similar facilities may be offered to men students. The report of the Joint Standing Committee for Research records a substantial output of research during the session.

Cambridge.—A syndicate consisting of the Vice-Chancellor; Sir J. J. Thomson, Master of Trinity; Prof. Seward, Master of Downing College; Dr. Willis, Dr. A. W. Hill, Dr. H. Hamshaw Thomas, Prof. A. G. Tansley, Sherardian professor of botany in the University of Oxford; A. Amos, R. A. Hayes, and F. L. Engledow has been appointed to consider the organisation and finance of the Botanic Garden and the relations between the Garden and the Department of Botany and other scientific departments, and to report to the University by the end of the ensuing term.

Edinburgh.—At a meeting of the University Court on Jan. 28, Principal Sir J. Alfred Ewing intimated his intention to retire from the principalship of the University on Sept. 30 next.

St. Andrews.—The Prime Minister, the Right Honourable Stanley Baldwin, has been elected Chancellor of the University and has written to Principal Sir James Irvine accepting the appointment.

Recently Mr. Paul F. Williams, a well-known engineer and business executive of Chicago, Illinois, established the Paul F. Williams Research Foundation Fund for the promotion of scientific research at Purdue University, West Lafayette, Indiana. This fund provides for several one thousand dollar annual research fellowships. At least two of these will be available for physical research in the Graduate School of the School of Science. This is but one of the many evidences of the business man's interest in the building of a research centre at Purdue University, where knowledge may be created through fundamental research and applied through industrial research.

Calendar of Patent Records.

February 9, 1832.—During the steam-carriage boom that started about 1821 and lasted some years, several companies were formed and projected to run lines of coaches. The London and Birmingham Steam Carriage Company built in 1833 a coach of the type invented by Dr. William Church of Birmingham, and patented by him on Feb. 9, 1832. The coach had a single front wheel and was carried on air springs; its driving wheels were 8 ft. 6 in. in diameter, and had elastic rims and spokes; they were mounted on separate axles and geared by chains to the engine shaft. The carriage did not prove very successful and was not used after a few short trials.

February 10, 1801.—Green-houses for vines and other plants came into general use during the eighteenth century. The first patent for a hothouse was granted on Feb. 10, 1801, to James Anderson, the editor of the rare periodical *The Bee; or Literary Weekly Intelligencer*, 1791–94, and the author of several agricultural works.

On the same day, Feb. 10, 1801, the first patent for a fire-resisting safe was granted to Richard Scott, a colonel in the employ of the East India Company. The safe consisted of an outer casing with double walls of metal and a filling of charred wood soaked in an alkaline solution, and an inner metal box supported on all sides by pins.

February 10, 1825.—A great improvement was made in the candle by the invention of the plaited wick, which became untwisted and consumed as the candle burnt. The invention was patented in France by Cambacérès on Feb. 10, 1825, but it does not appear to have reached England until some years later.

February 12, 1849.—During the first half of last century, especially after the invention of photography, the forgery of Bank of England notes was very common, and many inventors applied themselves to the problem of devising means to circumvent the forgers and safeguard the public. The new issue of notes which was made from the Bank in 1855 was printed on paper manufactured according to a process patented by William Brewer and John Smith on Feb. 12, 1849, in which the design for the watermark is engraved on steel dies and transferred by stamping to brass plates fitted within the paper-making moulds.

February 14, 1780.—The well-known letter-copying press was patented by James Watt on Feb. 14, 1780. The patent specification describes, in addition to the usual screw-press, a rolling-press, which is the form that Watt himself preferred to use.

February 14, 1876.—Several claimants, notably Reis in Germany and the Italians Manzetti and Meucci, dispute with Alexander Graham Bell the right to be called the inventor of the telephone, but it was undoubtedly on Bell's experimental work and his United States patent of 1876 that the commercial development of the telephone is based, and from which its use as a practical instrument dates. Bell's application for his original patent and a *caveat* from Elisha Gray for a similar invention at which he had arrived independently were filed in the U.S. Patent Office on the same day, Feb. 14, 1876, within an hour or two of each other, but the actual times of filing were sufficiently well authenticated to enable the Patent Office authorities to pronounce definitely in favour of the priority of Bell, and his patent was duly sealed. Applications from Gray, Edison, Dolbear, Berliner, and others, followed in quick succession, and heavy litigation was only settled by the Bell Company buying up the whole series of inventions.

Societies and Academies.

LONDON.

Royal Society, Jan. 31.—**S. Chapman**: On the theory of the solar diurnal variation of the earth's magnetism. A 'drift-current' theory is proposed, which may account for the major part of the solar diurnal magnetic variation, but at present a decision cannot be made between this and the 'dynamo' theory; both theories require that the diurnal convective motion in the conducting layer differs largely in phase from that observed in the lower atmosphere. —**G. M. B. Dobson, D. N. Harrison, and J. Lawrence**: Measurements of the amount of ozone in the earth's atmosphere and its relation to other geophysical conditions. Daily observations of ozone in the upper atmosphere show that there is a well-marked area, with much ozone, immediately to the west of cyclones, while ozone is generally small in anti-cyclones. Polar air currents in upper atmosphere are generally associated with much ozone and equatorial currents with little. There is large annual variation in amount of ozone in high latitudes, but very little in low. In autumn the amount of ozone is nearly uniform over the hemisphere.—**S. Chapman and J. M. Stagg**: On the variability of the quiet-day diurnal magnetic variation at Eskdalemuir and Greenwich. Corresponding daily values of percentage departure of actual from the 'normal' range of diurnal solar magnetic variation (ΔR) for the same element at the observatories are closely correlated, whereas there is much less correlation between corresponding values of ΔR for different elements at the same observatory. Actual range (R) or ΔR sufficiently characterises daily variation at any season, because variation is the same, except in scale, on days of large as on days of small range.—**L. H. Gray**: The absorption of penetrating radiation. Adopting the hypothesis that penetrating radiation is a type of γ-radiation, its absorption in the atmosphere is investigated from the theoretical point of view.—**R. d'E. Atkinson**: The probability of excitation by electron impact. Starting from the quantum theory point of view, a method is developed of analysing the results obtained by the Townsend type of experiment, in which currents of the form $i=i_0e^{ax}$ are found on varying the distance x between two parallel plates in a gas at comparatively high pressures. —**N. W. McLachlan**: Pressure distribution in a fluid due to the axial vibration of a rigid disc. Pressure distribution throughout the hemisphere on each side of a rigid disc, vibrating in a circular aperture in a plane wall of infinite extent, is considered. When wave-length is large compared with diameter of disc, pressure distribution is uniform over any hemispherical surface distant several diameters from disc. When wave-length is comparable with diameter, pressure decreases with increase in angular distance from axis. In general, the central zone is the only one of importance.—**J. D. Cockcroft**: Skin effect in rectangular conductors at high frequencies. At high frequencies the surface of the conductor becomes a stream-line in the magnetic field, and the problem of distribution of current becomes analogous to an electrostatic problem, surface current density corresponding to electrostatic surface density, whilst depth of penetration is the same as for infinite strips.—**L. Rosenhead**: Systems of line vortices in a channel of finite breadth. The investigations deal with a Kármán street of vortices, or unsymmetrical double row, in a channel of finite breadth. A discussion on the symmetrical double row has also been incorporated.—**T. P. Hilditch and N. L. Vidyarthi**: (1) The products of partial hydrogenation of some higher monoethylenic esters. A method has been worked out of determining the constitution of the isomeric acids produced in hydrogenation of derivatives of the oleic series. Methyl esters of oleic, palmitoleic and erucic acids each yield a mixture of three position-isomerides, namely, the original acid, and the two acids in which an ethylenic linkage is in either of the positions adjacent to that originally occupied. The bearing of this upon the general theory of contact action at solid surfaces is considered; the opposite geometrical isomeride of original ethenoid acid, and also formation of position isomers, seem to be due to dehydrogenation of freshly formed saturated ester prior to desorption from catalyst.—(2) The products of partial hydrogenation of some higher polyethylenic esters. The various ethenoid bonds are not usually hydrogenated at same rate, and the isomerisation phenomena discussed above are encountered. These complications are not sufficient seriously to interfere with the utility of the method as a means of determining constitution of polyethylenic derivatives.—**P. K. Kichlu and D. P. Acharya**: Infra-red radiations of active nitrogen. Photographic investigation of the spectrum from λ7500 to λ8900 shows that it is an extension of the first positive group of nitrogen in the green, yellow, and red regions. The most important group of lines of atomic nitrogen at about λ8200 is absent.—**T. H. Havelock**: The vertical force on a cylinder in a uniform stream. The method of successive images, taking images alternately in surface of cylinder and in free surface of stream, is used. The method can be applied to any submerged body for which image systems are known.—**R. C. J. Howland**: Stress systems in an infinite strip.—**A. H. Wilson**: Perturbation theory in quantum mechanics. The convergence of the series of perturbations is discussed. Though the series is not in general convergent, yet it usually possesses an asymptotic character, and its use is therefore justified.—**O. W. Richardson and K. Das**: The spectrum of H_2: the bands analogous to the orthohelium line spectrum.—**O. W. Richardson and P. M. Davidson**: The singlet bands of the hydrogen molecule (1). The strongest two band systems in the spectrum of H_2 belong to 3 to 2 electron transitions analogous to those of the parhelium line spectrum. The properties of the final state are given with great accuracy.

Linnean Society, Jan. 3.—**C. E. Moss**: A new genus of the Hydrocharitaceæ from the Zambezi. The freshwater plant discussed was collected in the River Zambezi, at its confluence with the River Linyanti, at Kazangula, above Livingstone, in Rhodesia. It was growing, staminate plants here and pistillate plants there, on the water-margin of a reed swamp, in water about three metres deep. Apart from the flowers, the whole plant was submerged. The petals are broad; the stamens number twelve, and are of four different sizes; six staminodes, three large filament-like ones and three small scale-like ones, occur in the pistillate flower. Moreover, the new plant is remarkable by its elongate and ligulate leaves, its elongate and terete peduncles, and its cylindrical and monophyllous spathes all covered with soft conical projections. The plants appear to be identical with the type-specimen of *Boottia muricata* Wright.

PARIS.

Academy of Sciences, Jan. 7.—**A. Lacroix**: The existence of tectites at Cambodia: their morphology. A résumé of the results of the examination of 1750 specimens, giving an account of the shape, fracture, and markings. The question of origin is reserved for later discussion.—**E. Fichot**: The extension of the method of geographical engineers to terms of the fourth order.—A. Stodola was elected *correspondant* for the Section of Mechanics, and William Bowie *correspondant* for the Section of Geography and

Navigation.—**Paul Delens**: Spherical operations and paratactic congruence.—**Ch. Bioche**: Ruled surfaces having skew cubics for asymptotes.—**V. Smirnoff**: The limit values of analytical functions.—**Soula**: The comparison of various theorems on Taylor's series.—**O. D. Kellogg** and **Florin Vasilesco**: Contribution to the study of the capacity and of Wiener's series.—**A. Demoulin**: A class of congruences.—**Jules Drach**: The transformation of partial differential equations of the second order by the explicit use of the characteristic variables of Ampère.—**Arnaud Denjoy**: A class of analytical functions.—**Alexandre Kovanko**: The approximation of generalised nearly periodic functions.—**A. Gay**: The slow, non-permanent movement of any cylinder in a viscous incompressible liquid.—**Ernest Esclangon**: Experiments in optical reflection and the asymmetry of space.—**Ludovic Gaurier**: Limnological studies in the French Pyrenees.—**Th. De Donder**: The photonic field and the relativist generalisation of the undulatory mechanics of Dirac.—**A. F. Joffé** and **A. N. Arsénieva**: Experiments on the polarisation of electronic waves. The negative results from these experiments concerning polarisation either by reflection or by the magnetic field are in full agreement with the undulatory theory of matter developed by C. G. Darwin and by J. I. Frenkel.—**J. Frenkel**: The impossibility of polarising the cathode rays by reflection.—**Henri Gutton**: The properties of ionised gases in high frequency fields.—**Jean Thibaud**: The effect of periodic concentration and expansion produced by a longitudinal magnetic field on a bundle of slow electrons. The effects produced on the trajectory of a bundle of slow electrons passing through the magnetic field produced by a coil carrying a continuous current resemble those produced on a ray of light passing through a lens, the convergence of which varies continuously.—**Léon** and **Eugène Bloch**: Intercombinations and new terms in the spark-spectrum of sulphur, S II.—**J. Dufay**: The absorption spectrum of oxygen and of ozone in the ultra-violet region.—**V. Dolejšek** and **K. Pestrecov**: The tendency of the values of the discontinuities of the *K* absorption of the simple bodies.—**Henri Belliot**: Influence of the nature of the fixer on the development after fixing of inverted or solarised photographic plates.—**P. Dejean**: The study of mechanical properties as a means of following the transformations of brasses containing 57·5-63·5 per cent of copper. Crushing tests at varying temperatures up to 900° C. have been carried out and the results given in a graph in which the crushing strength is plotted against temperature for several alloys. The curves show a point of inflection at 475° C. common to all the alloys, and a higher point, 685°-783° C., varying with the composition of the alloy.—**Albert Roux** and **Jean Cournot**: The internal transformations of a copper-aluminium alloy. Details of X-ray studies of a copper-aluminium alloy (90 copper, 10 aluminium) after various kinds of heat treatment.—**Pierre Jolibois**: The application of the theory of Smits to the allotropic varieties of phosphorus. The author contends that this theory, although attractive, is not in accord with the known facts concerning the allotropic varieties of phosphorus. It is regarded as proved that there are four varieties of solid phosphorus, namely, white phosphorus, ordinary red phosphorus, pyromorphic phosphorus and Bridgmann's black phosphorus.—**Clément Duval**: A cobaltic monammine. Werner has classified the cobaltiammines in seven series containing decreasing quantities of ammonia. Up to the present, no example has been known of the type $(Co . NH_3 . X_5) . M_2$. The preparation of a representative of this series is described, sodium cobalti-ammonioborate $(Co(BO_2)_5NH_3)Na_2$.—**R. Locquin** and **V. Cerchez**: Some derivatives of hydantoinacetic acid.—**Max** and **Michel Polonovski**: 3-Chlorotropane and the non-existence of Hesse's bellatropine.—**J. Orcel** and **Gil Rivera**: The microscopic study of the complex copper-silver minerals of Colquijirca (Peru).—**Robert Gibrat**: The variation with direction of the capillary constant of smectic bodies. An application of the Gauss theory of capillarity to smectic bodies.—**Maurice Blumenthal**: The succession and distribution of the tectonic units of the Mediterranean slope of the Betic Cordilleras between Grenada and Gibraltar.—**G. Nicolas**: An endophyte of *Lunularia cruciata*.—**N. N. Kourtiakoff**: The influence of the relief of the soil on fertility.—**P. Mazé** and **P. Evens**: Chlorosis in cultures on land under sewage irrigation: its cause and cure. This can be remedied by addition of iron salts.—**Harald Okkels**: The existence of a morphological specialisation at the level of the vascular pole of the renal glomerule in the frog.—**J. André Thomas**: The reactions of grouped living beings. The action of some alkaloids on *Convoluta Roscoffensis*.—**F. Holweck**: The production of monochromatic X-rays of great wave-length. Quantitative action on micro-organisms. Study of the action of X-rays of 4-8 A. on the pyocyanic bacillus. The results for rays of 4 A. and 8 A. are shown on separate curves and compared with the calculated curves.—**A. Lacassagne**: The action of X-rays of great wave-length on micro-organisms. The establishment of exact statistics of the mortality of the irradiated bacteria. A discussion of the technique necessary for exact determinations.—**Mme. P. Curie**: The study of the probability curves relating to the action of the X-rays on bacilli. A mathematical discussion of the matter in the two preceding papers.—**S. Mutermilch** and **Mlle. E. Salamon**: The local formation of antitoxins in the cephalo-rachidian fluid. The vasculo-meningeal barrier is impermeable to blood antitoxins formed in the animal organism as the result of the inoculation of anatoxins in the peritoneal cavity. The appearance of antitoxins in the cephalo-rachidian fluid of animals vaccinated by the intra-meningeal method is due to their local production by cells the nature of which has still to be ascertained.—**Georges Tixier**: The spectrographic verification of the activation of ergosterol under the influence of irradiation by ultra-violet rays. The curve of transmission of the ultra-violet rays and the curve of antirachitic activity, considered as a function of the time of irradiation, are parallel at first, and then deviate from each other as the time increases. The maximum of antirachitic activity does not correspond with the minimum transparency.

LENINGRAD.

Academy of Sciences (*Comptes rendus*, No. 23).—**A. A. Belopolskij**: Changes in the spectrum of the star α^2 in the constellation Canes Venatici. Observations of variations in the intensity of certain lines in the spectrum.—**N. Gajevskaja**: Some new pelagic infusoria from Lake Baikal. Descriptions of three new genera and four new species.—**C. Flerov**: The diagnostic characters in the genus *Capreolus* Frisch (fam. Cervidæ). Revised diagnoses of the genus and of its two species, *Capreolus capreolus* (Linn.) and *C. pygargus* (Pallas), the latter with three subspecies.—**J. Gueronimus**: The multiple polynome deviating least from the zero and with two first coefficients given.—**B. Schtylko**: A method of determination of fossil remains of Teleostei. In many cases it is possible to use for the identification of fragmentary fossils of Teleostei the shape and sculpture of scales; several examples are analysed.

Official Publications Received.

BRITISH.

The University of Manchester: The Manchester Museum. Museum Publication 96. Report for the Year 1927-28. Pp. 26. (Manchester.) 6d. net.

Proceedings of the Royal Society. Series A, Vol. 122, No. A789. Pp. 369. (London: Harrison and Sons, Ltd.) 12s.

Ministry of Health. Treatment of Tuberculosis: Analysis of Work done during the Year 1927 under the Schemes of Local Authorities for the Treatment of Tuberculosis, as shown in the Returns furnished in accordance with Memorandum 37/T. (Memo 131a/T.) Pp. 7. (London: Ministry of Health.)

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No 1167 (Ae. 331): Photographs of Streamers illustrating the Flow around an Airscrew in the Vortex Ring State By C. N. H. Lock (T. 2583.) Pp. 4+7 plates. 1s. net. No. 1177 (Ae. 341): A Brief Survey of Wing Flutter, with an Abstract of Design Recommendations. By R. A. Frazer and W. J. Duncan. (T 2592: T 2635) Pp. 31. 1s. 3d. net. (London: H.M. Stationery Office.)

Malta. Annual Report on the Working of the Museum Department during 1927-28. Pp. xx. (Malta: Government Printing Office.)

Journal of the Chemical Society: containing Papers communicated to the Society. December. Pp. iv+3091-3308+x. (London.)

Annual Report of the Indian Central Cotton Committee, Bombay, for the Year ending August 31st, 1928. Pp. ii+118+4 plates. (Bombay.) 2 rupees.

Survey of India. Map Publication and Office Work from 1st April 1927 to 31st March 1928. Pp vi+19+5 maps. (Calcutta.) 1 rupee; 1s. 9d.

Union of South Africa: Botanical Survey of South Africa. Memoir No. 12: Botanical Survey of the Springbok Flats, Transvaal. By Ernest E. Galpin. Pp vi+100+22 plates. (Cape Town: *Cape Times*, Ltd.)

Bothalia: a Record of Contributions from the National Herbarium, Union of South Africa, Pretoria Edited by Dr. I B Pole Evans. Vol. 2, Part 2, November 30th. Pp. 371-474. (Pretoria.) 7s. 6d.

FOREIGN.

United States Department of Agriculture. Technical Bulletin No. 81: The Hessian Fly in California. By C. M Packard. Pp. 26. (Washington, D.C.: Government Printing Office.) 5 cents.

Meddelanden från Statens Skogsforsoksanstalt. Hafte 24, 1927-28. Pp. iii+389. (Experimentalfaltet.) 8 kr.

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Verhandelingen No. 21: Sea-Surface Temperatures on some Steamer Routes in the Malay Archipelago By Dr. H. P Berlage, Jr. Pp. 54. (Weltevreden: Landsdrukkerij.)

Regenwaarnemingen in Nederlandsch-Indie. Negen en veertigste Jaargang, 1927 Pp. ii+131. (Weltevreden: Landsdrukkerij.)

Conseil Permanent International pour l'Exploration de la Mer Rapports et procès-verbaux des réunions. Vol. 49: Procès-verbaux (juin 1928). Pp. 175. Vol. 51: La pêche littorale sur les côtes de Belgique. Par G. Gilson. Pp. 178. (Copenhague. Andr. Fred. Høst et fils.)

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 45: Some Problems of Shocks transmitted in Bars and in Plates. By Katsutada Sezawa. Pp. 83-147. (Tôkyô: Koseikai Publishing Office.) 0.65 yen.

Scientific Papers of the Institute of Physical and Chemical Research No. 164: Die quantentheoretische Deutung der grunen Nordlichtlinie auf Grund interferometrischer Zeemaneffektmessung Von L A. Sommer. Pp 181-201. 30 sen. No. 165: On the Oxidation of Ferrous Hydroxide in Sodium Hydroxide Solution by Means of Air. By Susumu Miyamoto. Pp. 203-208. 15 sen No 166: Anomalous Dispersion and Absorption of Electric Waves (continued). By San-ichiro Mizushima. Pp. 209-231. 35 sen. No. 167: Uber das Krotengift, Mitteilung 3: Über giftige Bestandteile des Sekrets der japanischen Krote Von Munio Kotake. Pp 233-236 15 sen. (Tôkyô: Iwanami Shoten.)

Field Museum of Natural History. Anthropological Series, Vol. 18, No. 1: The Prehistory of Aviation. By Berthold Laufer. (Publication 253.) Pp. 96+12 plates. (Chicago, Ill.)

Proceedings of the United States National Museum. Vol. 74, Art 4: Two new Nematode Worms from Rodents By Emmett W. Price. (No. 2749.) Pp 5+2 plates Vol. 74, Art. 12: A new Polychaetous Annelid of the Genus Phyllodoce from the West Coast of Costa Rica By Aaron L. Treadwell. (No. 2757.) Pp. 3. (Washington, D.C.: Government Printing Office.)

Anuario del Observatorio Astronómico de Madrid para 1929. Pp. 488. (Madrid: Instituto Geografico y Catastral.)

Journal of the Faculty of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 23, Part 1: Chemical Studies on Sex Differences of Proteins in Animals and Plants (Second Report); i Sex Differences of Muscle-fibre (Sarkolemm); ii Sex Differences of Muscle Proteins. By T. Tadokoro, M Abe and S. Watanabe. Pp. 27. (Tokyo Maruzen Co, Ltd.)

Diary of Societies.

FRIDAY, FEBRUARY 8.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30—Capt. E. J. Headlam The History of the Indian Marine.

ROYAL ASTRONOMICAL SOCIETY (Anniversary Meeting), at 5.—Presentation of the Gold Medal to Prof. E. Hertzsprung, for his Determination of the Distance of the Lesser Magellanic Cloud and other Pioneering Work in Stellar Astronomy.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—L. F. Stanley: The Construction and Calibration of a Sensitive Form of Pirani Gauge for the Measurement of High Vacua.—H. C Webster: (*a*) Photographic Measurement of the Relative Intensities of the $L\alpha_1$, $L\alpha_2$, $L\alpha_3$ Lines of Silver; (*b*) Spark Satellites of the $L\alpha$ Lines of Silver.—Demonstration of a New Instrument for the Rapid and Accurate Determination of the Specific Gravities of Solid Substances, by W. A. Benton.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. R T. Payne: The Treatment of Varicose Veins and Varicose Ulcers by Injection.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.

BRITISH PSYCHOLOGICAL SOCIETY (Æsthetics Section) (at Bedford College for Women), at 5.30.—Dr. H. Lowery: Musical Memory and Rhythm.

MALACOLOGICAL SOCIETY OF LONDON (Annual General Meeting) (at University College), at 6.—Prof. A. E. Boycott: The Œcology of British Land Mollusca

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 6.—L. A. Legros and others: Discussion on The Profession of the Mechanical Engineer.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Newcastle-upon-Tyne), at 6.—Dr. G. W. Todd: The Prediction of the Properties of Engineering Materials from their Ultimate Structures.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—H. H. Taylour: Electric Welding.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Informal Technical Talk), at 7.—B. C. Wickison: Lantern Slides.

GEOLOGISTS' ASSOCIATION (Annual General Meeting) (at University College), at 7 30.—Prof A. Morley Davies: Formal Migrations since the Cretaceous Period (Presidential Address).

INSTITUTE OF METALS (Sheffield Local Section) (at Sheffield University), at 7.30.—W. T. Griffiths: Some Recent Developments in Nickel Metallurgy.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30—Dr. A. E. Dunstan: Recent Developments in the Art of Oil Cracking (Lecture).

BLACKBURN TEXTILE SOCIETY (at Blackburn Technical College), at 7.30.—S Kershaw: The Production of Worsted and Mixed Yarns.

TEXTILE INSTITUTE (Lancashire Section) (at Harris Institute, Lancaster), at 7.30—W. B. Crompton: Some Post-War Changes in Lancashire Cotton Mills.

KEIGHLEY TEXTILE SOCIETY (at Keighley), at 7 30.—K. A. Mountain and A B Maclean: Comparative Advantages of Private Plant and Purchased Power.

LEICESTER TEXTILE SOCIETY (at Leicester), at 7.30.—T. A. Holroyd: Hosiery Dyeing Operations.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Royal Society of Arts), at 8.—Prof. W. E. Gibbs: The Role of Surface Energy in Chemical Engineering.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—R. F Moore and Mr. Scott: Clinical and Pathological Report of Bilateral Glioma Retinæ.—R. F. Moore: Cirsoid Aneurysm of the Visual Cortex.—B. Graves: Scleral Illumination.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—C. E. R. Sherrington: Recent Problems of Rail Transport at Home and Abroad.

SATURDAY, FEBRUARY 9.

MINING INSTITUTE OF SCOTLAND (at 79 Grassmarket, Edinburgh), at 3.—Prof. H. Briggs: (*a*) The Mineralogy of Coal; (*b*) The Appearance of Coals, etc., in Ultra-Violet Rays—J. B. Sneddon: The Mining Congress in Canada in 1927.—*Papers open for discussion*:—Some Impressions of German Mining, D. C. Gemmell and J. Heron.—Tru-lay Wires, Ropes, and Tru-lock Fittings, A. T. Adam.—Pavement Brushing *versus* Roof Brushing, J. S. Frame.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. S. Marchant: Music in Cathedral and Collegiate Churches (I).

MONDAY, FEBRUARY 11

CAMBRIDGE PHILOSOPHICAL SOCIETY (in University Chemical Laboratory), at 4.30.—Prof T. M. Lowry: Configuration of Quadrivalent Atoms—Dr. F. G. Mann: The Stability of Complex Metallic Salts.—Dr. F. H. Constable: An Apparatus for the Study of Gas Reactions on Electrically Heated Films of Known Area.—C. P. Snow. The Structure of the Nitric Oxide Molecule.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Capt. E. R. L. Peake. The Tavistock Theodolite.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. H. A. Harris: Bone Growth in Health and Disease.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Centre) (at Queen's Hotel, Birmingham), at 7.—Dr. F. W. Lanchester: Coil Ignition.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7—J. Wright and C. W. Marshall: The Construction of the Grid Transmission System in Great Britain.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (Associates' and Graduates' Branch) (London and District) (at Borough Polytechnic), at 7.30.—J. L. Kinnell, Jr.: Cast Iron.

MEDICAL SOCIETY OF LONDON, at 8.—Dr. M. McCrea and H. Tilley: Earache.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Bristol).

TUESDAY, FEBRUARY 12

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: Evolution and the Problem of Species (III.)

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—J. S Parker and C. A. P. Southwell: The Chemical Investigation of Trinidad Well Waters and its Geological and Economical Significance.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (Students' Section) (at Birmingham University), at 5.30.—H. M. Stanley: The Production of Gaseous, Liquid, and Solid Hydrocarbons from Methane. Thermal Decomposition of Methane, Part I.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—G. J Scott: The Design and Construction of Electric Auxiliaries for Marine Service.

ELECTRICAL ASSOCIATION FOR WOMEN (at 15 Savoy Street), at 7—H. de A. Donisthorpe: Radio Progress and its Connexion with the Thermionic Valve.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—E. B. Wedmore, Dr W. B. Whitney, and C. E. R. Bruce: An Introduction to Researches on Circuit Breaking.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. M. Cartwright: The Limitations of Colour Photography.
INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch Burnley Section) (at Municipal College, Burnley), at 7.15.—Mr. Griffiths: Some Aspects of Modern Foundry Practice.
INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Centre) (at Rover Sports Club, Coventry), at 7.30.—Dr. F. W. Lanchester: Coil Ignition.
INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—W. B. Woodhouse: Overhead Electric Lines.
INSTITUTE OF METALS (North-East Coast Local Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—J. E. Newson: Metallurgy of Engineering.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—G. B. Butler: The Manufacture of Steel as applied to Shipbuilding and Engineering.
QUEKETT MICROSCOPICAL CLUB, at 7.30.—Annual General Meeting.
LIVERPOOL GEOLOGICAL SOCIETY (at Royal Institution, Liverpool), at 8.—Prof. H. L. Hawkins: Revolutions and their Effect on Life (Lecture).
ROYAL SOCIETY OF MEDICINE (Psychiatry and Neurology Sections) (*also on Feb. 14*), at 8.30.—Dr. W. H. B. Stoddart (Psychiatry), Sir James Purves-Stewart (Neurology), and others: Special Discussion on Prognosis and Treatment of General Paralysis of the Insane.
NELSON TEXTILE SOCIETY (at Nelson).—J. Kershaw: Fancy Effect Yarns.
MANCHESTER ATHENÆUM TEXTILE SOCIETY (at Manchester).—E. E. Canney: Economic Question of Vital Importance to the Cotton Trade.

WEDNESDAY, FEBRUARY 13.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (Annual General Meeting) (at Holborn Restaurant), at 2.30.—J. R. Preston: Presidential Address.—H. G. Cathcart: Water Softening by the Base Exchange Process.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. H. A. Harris: Bone Growth in Health and Disease.
ROYAL SOCIETY OF MEDICINE (Surgery: Sub-Section of Proctology), at 5.30.—W. B. Gabriel: Case of Carcinoma of the Rectum Complicated by Enlarged Prostate.—Dr. P. H. Manson-Bahr: Pathology of Bilharzia and Amœbic Dysentery of Colon and Rectum.—R. Maingot: Three Cases of Acute Intestinal Obstruction due to Fæcal Impaction.—A. L. Abel: Three Cases of Multiple Cancers of Rectum and Colon.
INSTITUTION OF CIVIL ENGINEERS (Informal Meeting), at 6.—H. P. Gaze: Merits of Alternative Methods of Driving Auxiliaries in Modern Power-Stations.
INSTITUTE OF METALS (Swansea Local Section) (at Thomas' Cafe, Swansea), at 7.—J. E. Malam: Recent Developments in Rolling Metal Strip and Sheet.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.—F. H. Todd: Ship Trials and their Analysis.
HALIFAX TEXTILE SOCIETY (at Halifax), at 7.30.—G. Shackleton: Weaving of Fancy Cloths.
ROYAL PHILOSOPHICAL SOCIETY OF GLASGOW (at 207 Bath Street, Glasgow), at 8.
ROYAL SOCIETY OF ARTS, at 8.—C. Hooper: The Pollination of Fruit Blossoms and their Insect Visitors.
EUGENICS SOCIETY (at Linnean Society), at 8.—Mrs. M. Hawkes, Dr. Drysdale, and others: Discussion on Democracy and Heredity.
ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (at Northampton Polytechnic Institute), at 8.15.—S. Wernick: The Electrodeposition of Cadmium for Rust Prevention.
INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Branch).—Prof. A. S. Eddington: Engineering Principles in the Machinery of the Stars (Thomas Hawksley Lecture).
TEXTILE INSTITUTE (London Section).—G. A. Rushton and others: Informal Discussion on Identification of Textile Fibres.

THURSDAY, FEBRUARY 14.

IMPERIAL COLLEGE CHEMICAL SOCIETY (jointly with Royal College of Science Mathematical and Physical Society) (at Royal College of Science), at 5.—Prof. G. I. Finch: Electro-metallurgy (Public Lecture).
LINNEAN SOCIETY OF LONDON, at 5.—E. E. Edwards: On the Morphology of the Larva of *Dorcus parallelopipedus* L.—E. Taylor: Exhibition of Lantern-slides of Scottish Plants.—R. S. Bose: Biology of Wood-rotting Fungi.—A. G. Lowndes: Lantern-slides of Edge Island, Greenland: Variation in Arctic Freshwater Entomostraca.
LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. O. Veblen: Generalised Projective Geometry (Lecture).
ROYAL SOCIETY OF MEDICINE (Balneology Section), at 5.—Discussion on Osteo-arthritis:—Dr. R. G. Gordon, Dr. J. A. Thomson: Osteo-arthritis Radiographically Considered.—Dr. T. Hare and Dr. H. Cohen: The Chemical Estimation of Synovial Fluid and Blood Serum of Horses Affected with Chronic Arthritis.
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: The Early History of X-rays (III.).
BIOCHEMICAL SOCIETY, BIRMINGHAM UNIVERSITY, at 5.30.—Prof. J. C. Drummond: Problems of Vitamin Research.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—W. Cruickshank: Voice-frequency Telegraphs.
ROYAL AERONAUTICAL SOCIETY (jointly with Institution of Automobile Engineers) (at Royal Society of Arts), at 6.30.—A. H. R. Fedden: Air-cooled Engines in Service.
SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Engineers' Club, Birmingham), at 7.—D. W. Parkes: Disposal of Ammonia Liquors.
SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (at Bristol University), at 7.30.—Dr. C. A. Edwards: Some Chemical Aspects of Tinplate Making.
INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—W. B. Woodhouse: Overhead Electric Lines.
INSTITUTE OF METALS (London Local Section) (at 83 Pall Mall), at 7.30.—Some Present-Day Metallurgical 'Tools' and Methods:—Dr. C. J. Smithells: The X-ray Spectrometer.—S. V. Williams: Quantitative Spectroscopic Analysis.—H. Wrighton: High Magnification Microscopy.—W. E. Prytherch: Dilatometers.—A. J. Murphy: Preparation of Some Unusual Metallographic Specimens.
INSTITUTE OF METALS (Scottish Local Section, jointly with Institution of Engineers and Shipbuilders, and Institute of British Foundrymen) (at 39 Elmbank Crescent, Glasgow), at 7.30.—Dr. W. Rosenhain: Alloys—Past, Present, and Future.
OPTICAL SOCIETY (at Imperial College of Science), at 7.30.—Dr. D. S. Perfect: An Application of the Interferometer to the Goniometry of Prisms.—Demonstration of Prof. Coker's Photo-Elastic Apparatus (1928 Model) by Adam Hilger, Ltd.
LEICESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemistry Section) (jointly with Leicester University College Biological Society) (at Leicester University College), at 8.—Prof. E. C. C. Baly: The Photosynthesis of Carbohydrates from Carbonic Acid.
BRITISH INSTITUTE OF RADIOLOGY, at 8.30.
BATLEY AND DISTRICT TEXTILE SOCIETY (at Batley).—W. F. Vickers: Oils and Wool.
INSTITUTION OF MECHANICAL ENGINEERS (Leeds Branch).—Prof. A. S. Eddington: Engineering Principles in the Machinery of the Stars (Thomas Hawksley Lecture).
INSTITUTION OF MECHANICAL ENGINEERS (Manchester Branch).

FRIDAY, FEBRUARY 15.

GEOLOGICAL SOCIETY OF LONDON, at 3.—Annual General Meeting.
ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 4.30.—Geophysical Methods in Surveying. Chairman: Sir Gerald Lenox-Conyngham. Speakers: Mr. Broughton-Hedge, Dr. W. F. P. McLintock, and others.
BRITISH INSTITUTE OF RADIOLOGY (Medical Members), at 5.—Informal Discussion on Chest.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. H. A. Harris: Bone Growth in Health and Disease.
INSTITUTION OF MECHANICAL ENGINEERS (Annual General Meeting), at 6.—H. J. Ward: Refrigeration on Ship-board.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group—Informal Meeting), at 7.—Discussion on the Stephan H. Tyng Foundation Prints.
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—E. G. Ritchie: Steam Storage.
ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Discussion on Chronic Rheumatism of Joints and Muscles: Diagnosis and Treatment.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. E. K. Rideal: Chemiluminescence.
SOCIETY OF DYERS AND COLOURISTS (Manchester Section, jointly with Manchester Section of Oil and Colour Chemists' Association) (at Manchester).—F. Scholefield: The Ostwald Colour System.
SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (jointly with all Glasgow Chemical Societies) (at 207 Bath Street, Glasgow).—Prof. G. T. Morgan: Chemical Studies of Coal Tar Products.

SATURDAY, FEBRUARY 16.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. E. Bullock: Music in Cathedral and Collegiate Churches (II.).
EUGENICS SOCIETY (at Rembrandt Hotel, Brompton Road), at 7.30.—Major L. Darwin: The Coming of Age of the Society (Galton Lecture).
PHYSIOLOGICAL SOCIETY (at Birmingham University).

PUBLIC LECTURES.

FRIDAY, FEBRUARY 8.

LONDON SCHOOL OF ECONOMICS, at 5.—C. E. R. Sherrington: Railway Electrification and the Redistribution of Industry.

SATURDAY, FEBRUARY 9.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: Life Beyond the Low-Tide Mark.

MONDAY, FEBRUARY 11.

KING'S COLLEGE OF HOUSEHOLD AND SOCIAL SCIENCE, at 5.15.—Prof. G. S. Gordon: The Lives of Authors.
UNIVERSITY OF LEEDS, at 5.15.—Prof. C. Lovatt Evans: The Principle of Adaptation in Physiology.
UNIVERSITY COLLEGE, at 5.30.—Prof. J. G. Andersson: Archæological Research in China. (Succeeding Lectures on Feb. 13 and 15.)—Dr. J. Bonar: Demography in the 17th and 18th Centuries (Newmarch Lectures). (Succeeding Lectures on Feb. 18, 25, Mar. 4, 11, and 18.)
EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—Prof. J. A. Hanley: Grassland Management.

TUESDAY, FEBRUARY 12.

IMPERIAL COLLEGE—ROYAL SCHOOL OF MINES, at 5.30.—F. L. Engledow: Plant Breeding. (Succeeding Lectures on Feb. 14, 19, and 21.)
UNIVERSITY COLLEGE, at 5.30.—Dr. G. M. Morant: The Rhodesian Man and his Relationship to other Types of Man.

THURSDAY, FEBRUARY 14.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—J. E. Quibell: Egyptian Architecture.

FRIDAY, FEBRUARY 15.

LONDON SCHOOL OF ECONOMICS, at 5.—C. E. R. Sherrington: Motor Transport and Urbanisation of the Countryside.

SATURDAY, FEBRUARY 16.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss I. D. Thornley: Travel and Travellers in the Middle Ages.

SATURDAY, FEBRUARY 16, 1929.

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Forests and the Royal Commission on Agriculture in India.

SEVERAL aspects of the Report of the Royal Commission on Agriculture in India have already been commented upon in NATURE (July 24, Aug. 4, and Nov. 17, 1928). The position of forestry in the different Provinces is dealt with in the appropriate sections, and the evidence before the Commission has recently been published. Perhaps the first point which strikes a forester after reading the chapter on forests in the Report of the Commission is the Commission's apparent acceptance of the definition of 'forest' as areas producing large timber. "Many of the forests of the plains," the Commissioners remark, "are forests only in name. Few timber trees are to be found in them, but they provide a certain amount of fuel and grazing." It is to be hoped that this definition will not come to be accepted for the forests of the British Empire.

In the most intensively managed forests in some European countries the definition of 'forests' includes both categories, and it has come to be recognised as the result of much bitter and costly experience that the management of the second category, the fuel and grazing grounds, is often the most difficult. It cannot be left to either the village community or to the civil officers. For the efficient management and improvement of such forest areas the highest professional talent, coupled with administrative experience and great tact, is required. It is for this reason that we find in some parts of Europe senior executive officers possessed of these attributes delegated to the charge of 'forest' areas, "forests only in name," as the Commissioners term them, of which the sole reason of maintenance is the provision of fuel and grazing for the agriculturist. In fact, such 'forest' areas, for they are unquestionably accepted as forests coming within the work of a Forest Department, are as necessary for the well-being of the agriculturist as the big timber forests, the produce of which is required for the industrial sections of the community.

In connexion with the timber forests, it is stated with truth that the bulk of the areas are inaccessible to the vast majority of cultivators. This is an obvious fact (not restricted to India alone), and the inevitable aftermath of ill-regulated expansion of agricultural lands in the past, with no due provision being made by the reservation of blocks of forest in suitable positions, even though situated on land adapted to agriculture. This has been the history of the past development of agricultural India. Between the sixties and eighties of last century,

forest officers often directed attention to the point, but their voices went unheard when balanced against the clamour for the land and the revenue to be obtained from it by the development of agriculture. It is, however, incorrect to state that the distances of the timber forests and the difficulties of transport "result in the great mass of the agricultural population deriving little or no direct benefit from the forests proper." In many countries, the main forests nowadays are situated in the hilly regions and serve to protect the sources and catchment areas of the chief rivers and their tributaries. The agriculturist in the plains is directly dependent upon the water from these areas, although, as often in India, he may be situated several hundred miles distant. The maintenance of an even flow in the rivers and in the spring level of the underground water which feeds innumerable tanks and wells used for watering the crops in India would certainly undergo a drastic change for the worse were the distant timber forests to disappear.

The observations, questions asked of witnesses, the deductions arrived at by the Commissioners, and their recommendations on the subject of the forests in their relation to agriculture, are of considerable importance, since the latter forms the basic industry of the country. Briefly, the chief subjects considered may be enumerated as grazing, fuel requirements and their nature, and the question of the formation of forest areas, the object of which should be the provision of grazing and fuel on a regulated basis of management. There is much else in the Report of interest to the forester, but here we confine ourselves to the three points mentioned.

The Commission devoted considerable attention to the forest grazing business and to the efforts which had been made by cutting and baling grass from the forest to induce the villagers to make use of the dry grass instead of taking the cattle out daily to the forest. So far, the villager has persistently refused to make use of baled grass or to alter his age-long customs. He accepts it as an inevitable ration in times of famine when distance precludes him from sending his cattle to the forests, which are thrown open to all the animals which can reach them. In many forests of the country, serious harm has resulted from the excess grazing of animals in the forest, under which all young growth is browsed and the soil becomes beaten down and hardened under the hoofs of successive generations of animals. "It is," say the Commissioners, "from the Forest Department more than any other that complaints are heard of overstocking of grass land with animals of no economic value, for this is a subject that is being constantly forced upon their notice in the extensive grazing areas under their control." The forest officer, perforce, sees most of this grazing business, since he has to provide for the animals. But it is surely an anomaly to fix the responsibility for the failure of the villager to make use of baled grass or to improve his herd of animals upon the forest officer; and yet successive famine and agricultural commissions, etc., have done so in this matter of cattle and grazing.

The forest officer is, however, not responsible for the village or villagers and their agricultural methods. The onus in this respect lies with the agricultural departments, and in earlier days rested entirely upon the civil district officer. The remarkable increase in the numbers of the cattle, sheep, and goats throughout the country, following upon the settled order introduced and maintained by the British, could not perhaps have been foreseen; but whenever the question has come up during the past half-century, those who should have been responsible for the development of agriculture in all its phases, including animal husbandry, simply followed the old methods of the natives, and the forest officer was ordered to make provision for grazing, which each decade became heavier, once the villager had entirely destroyed, by over utilisation, the grazing lands in his vicinity.

The Commissioners accept, however, the continuance of forest grazing. "Since," they write, "it cannot be doubted that grazing in forests will, for a very long time to come, be an important feature of forest economy, we consider it essential that the intensity of grazing, consistent both with the proper development of the forest and the preservation of desirable grasses, should be determined as soon as possible. The Chief Conservator of Forests in the United Provinces informed us that knowledge in both these respects is at present defective." Yet, it may be pointed out, the answer was supplied (paragraph 183) by the Chief Conservator of Forests of Bengal, who, in referring to the deterioration of forests through excessive grazing, observed: "What appears to be light grazing in terms of head of cattle per acre is, in practice, concentrated near the village, in stream beds and grassy blocks; the last two being just where it does most harm." How could it be otherwise? The cattle leave the village in charge of an urchin or two soon after sunrise and return in the red evening light as the sun is dropping on to the horizon. Two to four miles from the village is the utmost reached.

The fuel or firewood (for it is chiefly the latter)

question is to some small degree analogous to that of the fodder one. One factor governs both, so far as the agriculturists dwelling away from forest areas are concerned, and this is the cost of carriage of the materials. Suggestions are made to the railway management upon this head. As is well known, over large tracts of India the only fuel used is cowdung. In the past the forest officer has often received ignorant censure for his inability to help to change this state of affairs whereby the manure of the fields is used to cook the food of the agriculturist. Of course, the problem is one for the Agricultural Department and its experts to deal with; but the Commissioners, although recommending methods of dealing with the provision of grazing and fuel lands, frankly show up the true position when they write (in connexion with the Central Provinces): "A scheme to place at the disposal of the people cheap firewood from fuel depots at convenient centres in order to remove the need for burning cowdung has not met with encouraging results. The continuance of this immemorial custom with firewood stacked almost at their door suggests that it is not lack of firewood which robs the soil of valuable manure"!

The Commissioners refer to the deplorable results of shifting cultivation (a matter which has already been treated upon elsewhere in NATURE), and they deal at some length with suggestions for improving the supply of fuel and grazing for villages when it is deficient throughout the country. Their recommendations, put briefly, are that areas should be earmarked and maintained for this sole purpose. They realise that their suggestion is not a new one; that in Bombay this method was already under trial, the areas so maintained being termed 'Minor Forests'; whilst in Madras the so-called poor scrub forests and grazing lands were being placed under 'panchayet' (that is, village) management.

The Commissioners express no opinion as to the better form of management, that is, whether this type of forest area should remain under the Forest or Civil Department, but they advocate a study of the subject of establishing this type of 'minor forest' in order that each village will enjoy easy grazing and cheap fuel. In these recommendations they will certainly have the hearty sympathy and the cordial support of the Forest Department. But, in conclusion, the warning note with which this article commenced may be sounded once again. Grazing and fuel areas, the primary object of which is to supply the requirements of a collection of individuals forming a village community who regard the area as their own property, require the most careful expert supervision and management if they are to continue to fulfil the objects of management. Once relax the supervision and each individual will exert himself to get his share. The Commissioners in dealing with Bengal appear to realise this. They write: "But it is not easy to convince the villager who needs fuel and the proprietor who needs cash, that temporary self-denial will be more than repaid later on"!

The Theory of Atoms.

The Greek Atomists and Epicurus: a Study. By Cyril Bailey. Pp. ix + 619. (Oxford: Clarendon Press; London: Oxford University Press, 1928.) 24*s*. net.

THE brilliant achievements of Hellenic genius in literature, art, politics, philosophy and mathematics have cast a reflected glory upon those Greek theories which may be considered as lying within the province of natural science. This refulgence is apt to tire our mental retina, and we are perhaps too prone to assume an inherent luminosity where, in point of fact, none exists. There is a tendency easily comprehensible but nevertheless entirely illogical to imagine that, since the Greeks excelled in philosophy, a similar excellence is to be found in their scientific attitude and theories. It was, however, long ago pointed out by Whewell that "as soon as they had introduced into their philosophy any abstract and general conceptions, they proceeded to scrutinise these by the internal light of the mind alone, without any longer looking abroad into the world of sense. They ought to have reformed and fixed their usual conceptions by observation; they only analysed and expanded them by reflection." Without going so far as to agree with his conclusion that "the whole mass of Greek philosophy therefore shrinks into an almost imperceptible compass when viewed with reference to the progress of physical knowledge," we may yet admit the general truth of his criticism; and we should take especial care not to read into the ancient theories conceptions which are essentially modern.

There is, however, a more serious defect in Greek science than this irrepressible habit of disproportionate speculation. It is that the Greek attitude towards Nature was to a large extent irrational, not merely in the riotous efflorescence of Neo-Platonism but even in the greatest philosophers of the classical period. Classical scholars may possibly regard this statement as heretical, but it would be easy to give chapter and verse to

confirm it. Indeed, Prof. Lynn Thorndike, in his excellent "History of Magic and Experimental Science," has already observed that Greek science was riddled with superstition, magic, astrology, and occultism of all kinds: "we cannot explain away the vagaries of the *Timæus* as flights of poetic imagination or try to make out Aristotle a modern scientist by mutilating the text of the *History of Animals*." Hellas bequeathed to civilisation the priceless gift of logical deduction, but lacked the spirit of modern science. "Everything," said Thales, "is full of gods."

Lastly, Greek science made no effective use of experiment, even if it did not actually despise it. The technical ability of Greek craftsmen is undeniable, and we are certain, therefore, that the philosophers could have found plenty of material for experiment if they had but realised its importance. This realisation was, however, not vouchsafed to them; nor, in fact, did it permeate the body scientific until comparatively recently. Even so late as the eighteenth century, we read, the professor of chemistry at the Jardin des Plantes never soiled his fingers with chemicals—he left that to an inferior personage, the demonstrator.

Having said the worst of Greek science, we can the more readily agree that its chief theory, that of atoms, is free from the gravest of the three defects enumerated above; for on its physical side it cannot in any legitimate sense be described as tainted with superstition. The atomic theory, especially perhaps in the form given to it by Democritus, has undoubtedly a right to be regarded with reverence by men of science, for although the modern theory is related to that of the Greeks much as a man is related to one of his simian ancestors, the continuity is unbroken from Leucippus to Dalton. Mr. Cyril Bailey's fine study of atomism will consequently be of as great interest to men of science as to students of the humanities; and the former will particularly welcome the restrained way in which he makes his comparison between the ancient and modern theories. "Ancient speculation," he frankly admits, "is a very different matter from modern research: at its best it rested in the main on *a priori* reasoning, and though observation and even experiment may have given some knowledge of detail, they had little place in the development of the larger fundamental theories. And not only do methods differ, but the fundamental conceptions of the atom in the ancient theory and modern chemistry are widely divergent." To this 'gesture' it would be churlish not to reply with an equally frank admission that Newton and Dalton ultimately owed their inspiration to Leucippus, Democritus and Epicurus, and that but for the speculations of ancient Greece the modern theory may never have seen the light. It is, in truth, a pleasure to be able to follow Mr. Bailey through the pages of his story without feeling that we are swerving from our allegiance to those two geniuses who established the atomic theory as we know it.

Mr. Bailey first describes the antecedents of atomism and then passes on to Leucippus, who, he says, regarded himself, and was generally considered in antiquity, as a mediator between the Eleatic Monism of the successors of Parmenides and the Pluralism of Empedocles and Anaxagoras. The atomic theory, as conceived by its founder, Leucippus, was "a reconciliation of those many antinomies which had sprung up in the course of earlier discussion, the One and the Many, change and permanence, division and continuity, the senses and thought." Democritus elaborated the theory into a more or less universal system. Receiving it from Leucippus as a rather crude and tentative speculation, he left it in a highly developed and strengthened form: "with him, Atomism as such reached its highest development in Greece." In the hands of Epicurus, to whom more than half the book is devoted, the atomic theory became even more complex, and although the physical hypotheses which it expounds are of extremely great interest, the scientist cannot bring himself to approve of such devices as the postulation of a 'swerve' in the path of the atoms, in order to escape from the determinism of Democritus. It is of course in this and similar respects that the modern theory differs so much, not merely in form but also in spirit, from the great scheme so lucidly and beautifully described by Lucretius. That free will has its explanation in the deviation of atoms from a rectilinear path is conceivable, but as a scientific hypothesis it is merely useless. Dalton's theory is very much simpler than that of Epicurus, because it assumes less and attempts to explain less; yet in point of fact it has explained much more.

It would be an impertinence for us to offer any opinion upon Mr. Bailey's conclusions from the literary point of view; but from that of science we may thank him for an unusually clear exposition of the birth and early life of one of the greatest of scientific theories. His book must be for many years the most authoritative on the subject, and, unlike many 'authorities,' it is a delight to read.

E. J. Holmyard.

Solutions and Heat Engines.

Gases and Liquids: a Contribution to Molecular Physics. By Dr. J. S. Haldane. Pp. xv + 334. (Edinburgh and London: Oliver and Boyd, 1928.) 18*s.* net.

THIS volume originated in the attempts of the author to apply current conceptions of osmotic pressure to physiological processes. He appears to have been led on from one subject of physics to another, and to have found difficulties at every step. The source of these difficulties is apparently to be sought in a tendency to take the elementary statements in text-books as representing the best knowledge on a subject, whereas in all such elementary instruction it is usually necessary to strip the subject bare of all complications. It may perhaps quite rightly be urged that this simplification is carried to excess, and that it does often mislead a student. For example, van 't Hoff, in his desire to show that for dilute solutions there was a close analogy between the laws of osmotic pressure and those of gases, concentrated attention on such cases and bent all his energies to demonstrate this analogy in all its details and the consequences of it. By doing this he was able to show that the resemblance between the two phenomena was so complete, not only qualitatively but even quantitatively, that there could be no doubt that osmotic pressure and gas pressure were due to the same cause. But at the same time the consideration of more complicated cases was left on one side, and such cases were often forgotten.

Of course, when concentrated solutions are considered, there are difficulties, just as there are for gases; but this does not take away the importance of the truth that the gas theory of osmotic pressure is the only theory from which it has been possible to calculate the pressure. Moreover, any other theory which may be put forward as an alternative explanation must not only explain the pressure but must at the same time *explain away* the effects that must arise from the molecular bombardment. However, Dr. Haldane will have none of this. The theory to him "is inherently unintelligible." He resuscitates the old idea that the pressure goes the wrong way. He will see that his objection is invalid if he will consider that the effect of the bombardment is to tend to expand the volume of the solution, and that therefore if water can flow in through a membrane it will do so.

Similarly, Dr. Haldane is 'up against' van der Waals: "van der Waals' interpretation of his equation is, however, not only very improbable, but . . . would make it impossible to extend the dynamical theory to the phenomena observed in liquids." "The theory of van der Waals treated gases as if they were already liquids, and it could thus give no account whatever of condensation to the liquid form, or of a critical temperature."

Statements such as these are not of rare occurrence, but may be taken as characterising Dr. Haldane's attitude towards his subject. It is when he comes to consider Carnot's principles and the ideal engine by which Carnot demonstrated them that his antagonism to physical conceptions is most conspicuous and startling. He makes much of the fact that it is not possible to make such an ideal engine. The valid conclusion to draw is that no real engine will have an efficiency so great as that demanded by Carnot (and by those who transformed his views to suit the law of conservation which was unknown to Carnot). Dr. Haldane claims to show "that existing kinds of heat-engine can, as a matter of fact, work far more efficiently between two temperatures than a Carnot engine." We fail to follow how he comes to this conclusion, especially as in the engines described by him the formula which he himself gives indicates only *half* the Carnot value for a given pair of temperatures. There is some confusion here which requires further elucidation. But assuming the validity of Dr. Haldane's claim, we would commend it to the attention of central heating engineers, for there should be commercial profit in it.

The Geology of Southern Africa.

Geologie der Erde. Herausgegeben von Prof. Dr. Erich Krenkel. *Geologie Afrikas.* Von Prof. Dr. Erich Krenkel. Zweiter Teil. Pp. xii + 463-1000 + Tafeln 22-37. (Berlin: Gebrüder Borntraeger, 1928.) 45 gold marks.

SOUTH AFRICA is of special geological interest from its simplicity and symmetry of structure, its instructive series of pre-Palæozoic rocks, its Karroo formation, with a succession of terrestrial deposits ranging from the Carboniferous to the Jurassic, and with important fossils, glacial beds, and vast lava sheets, the clues given by its Cretaceous beds as to the arrangement of ocean and continent in the South Atlantic region during the Upper Mesozoic, and its unique mineral deposits of diamonds, gold, platinum, and chromium, and its vast stores of coal. The second volume of Prof. Krenkel's "Geologie Afrikas" has been appropriately devoted to South Africa, which, owing to its unity, is well adapted to monographic

description. The area described lies south of the Lower Zambezi, and farther west is bounded in general by the southern watershed of the Congo; the book therefore deals with Northern and Southern Rhodesia, all the Union of South Africa, and Mozambique, of which the treatment is proportionately briefer than the rest.

The country consists of a high interior plateau bounded by a belt of lowland which contains many marine deposits—Devonian and Carboniferous in the Cape, and Cretaceous and Kainozoic in Natal, Mozambique, and along the western coast. Marine rocks have often been reported on the plateau, and some of pre-Palæozoic age are accepted by Prof. Krenkel on lithological evidence which is perhaps inconclusive; the only strong case is for some beds containing fragments identified as *Eurydesma* near Keetmanshoop, which were described as marine by Schroeder in 1908; in view of the significance of this occurrence, and the fact that reports of marine fossils from other localities, as from the Otavi Dolomite, have not been confirmed, a full account of the fossils from this bed would be useful. The boundary between this coastal belt and the plateau has been generally known as the Great Escarpment, and Prof. Krenkel in his interesting chapter on South African physiography has renamed it the Rogerstufe, after the head of the Geological Survey of South Africa.

This volume has the advantage of following Dr. du Toit's "Geology of South Africa," 1926, but it shows full evidence of independent preparation. The two works are on somewhat different lines, which make them usefully complementary. Instead of the abundant photographic plates which illustrate du Toit's volume, the chief illustrations provided by Prof. Krenkel are a valuable series of excellent geological sketch maps and sections. The opinions of the two authors are most in conflict over the bearing of South Africa and South America on Wegener's view that the Atlantic was formed by the westward drift of America. Dr. du Toit is a strong supporter of that theory. Prof. Krenkel, on the other hand, declares (p. 613) that the mountain systems of the two areas differ in form, in the nature of their folding, their tectonic divisions, age, and geographical arrangement, and holds that owing to these differences the composition of these mountains of similar material is of no weight as evidence of their original connexion.

Prof. Krenkel agrees with Dr. du Toit and differs from the late Prof. Schwarz and others as to the age of the Waterberg System, which he places in the Palæozoic; he refers to the presence of some impressions that have been regarded as crinoid stems, but the evidence for them should be quite distinct to be admissible in view of the other indications that these beds are of terrestrial origin. Prof. Krenkel's account is especially valuable in dealing with South-West Africa, for which Kaiser's great monograph was not available to Dr. du Toit.

The chapter on the economic geology is brief in proportion to the rest; the description of the mineral deposits includes the platinum lodes which are the latest addition to South African mineral wealth, and promise a welcome source of supply of that sparse and necessary metal.

The bulk of the volume is occupied by detailed descriptions of South African geology, which are full and clear and accompanied by well-selected bibliographies. The work contains less original matter than the first volume, which included areas which Prof. Krenkel had investigated personally; but it will form an indispensable work of reference to those interested in African geology.

Our Bookshelf.

The Development of the Human Eye. By Ida C. Mann. (Published for *The British Journal of Ophthalmology.*) Pp. x + 306. (Cambridge: At the University Press, 1928.) 36*s.* net.

As Sir John Parsons has made clear in his foreword, this is no ordinary book or compilation, but a record of original observation on a subject of great scientific interest and practical importance. For several years, at meetings of the anatomical and various ophthalmological societies, Dr. Ida Mann has been giving demonstrations on the development of one or another feature in the human eye, which attracted particular attention by reason of the fullness of the evidence submitted and the lucidity of her exposition of the facts and their meaning.

The admirable treatise Dr. Mann has written is based upon Prof. Ernest Fraser's collection of human embryos. Her treatise provides the most complete account we have of the histogenesis of the human retina, lens, vitreous and their investing membranes, and material for the correct solution of scores of doubtful issues, which within the compass of a mere review it is not possible to enumerate. Particular mention must be made of the 241 illustrations, the great majority of which are the author's own draughtmanship, remarkable alike for their clearness and adequacy, as well as for their artistic charm. The Cambridge University Press has done full justice to Miss Mann's drawings, which have been reproduced on a generous scale. The book forms a valuable addition to our knowledge in such an attractive form that it is certain to become a standard work for the student to read

and the practitioner to consult. It has a useful bibliography.

The directors of the *British Journal of Ophthalmology* are to be congratulated on promoting the publication of a treatise which not only reflects the greatest credit on the author and the Medical School at St. Mary's Hospital, but also adds distinction to British ophthalmology.

Dizionario di sinonimi e composti chimici con relative formole e pesi molecolari e le terminologie : chimica, farmaceutica, alchimistica. Per Prof. Calisto Craveri. Pp. vi+316. (Milano : Ulrico Hoepli, 1928.) 35 lire.

This book is divided into two parts, the first and larger of which is composed of a list, in alphabetical order, of upwards of 30,000 terms, consisting mostly of the Italian names of chemical compounds, together with their synonyms. Included also are short accounts of the origin and meaning of such words as acetification, acid, balsam, compound radicals, cupellation, extractives, liquation, refining, saponification, spirit, substitution, vitriol, etc. Some of the commoner alchemistic and pharmaceutical terms are also explained. The second part comprises two lists of the names, formulæ, and molecular weights, (1) of those inorganic compounds, and (2) of those organic compounds, for which no synonyms exist.

A great amount of labour must have been expended in the compilation of this volume, but the results cannot be described as other than highly unsatisfactory. The first part may be of some interest to the student of chemical history, but throughout the book frequent errors occur in the formulæ and in the molecular weights. Even the molecular weights of such simple substances as sulphurous acid, fuming sulphuric acid, and aluminium phosphate are incorrectly given, and that of alumina is written 012·20; aluminium carbonate and aluminium fluoride are allotted wrong formulæ. The symbol of boron is given as both Bo and B, and that of fluorine as both Fl and F. Moreover, in many instances, for example on pp. 110-111, the items are arranged out of order.

The book would need very thorough revision before it could be recommended.

British Museum (Natural History) Catalogue of the Pontian Bovidæ of Europe in the Department of Geology. By Dr. Guy Ellcock Pilgrim and Arthur Tindell Hopwood. Pp. xii + 106 + 9 plates. (London : British Museum (Natural History), 1928.) n.p.

The authorities of the British Museum of Natural History are to be congratulated on the form in which they are now issuing the catalogues of their palæontological collections. These now come out singly, each one dealing with a particular group or subject, in a bound volume very convenient both for handling and reference.

The latest to appear is an account by Dr. Pilgrim and Mr. A. T. Hopwood of the Pontian Bovidæ of Europe as far as the subfamilies Gazellinæ, Pseudotraginæ, Bubalidinæ, Hippotraginæ, Cervicaprinæ, and Tragelaphinæ. In the preface, Dr. Bather, lately Keeper of the Geological Collections, utters a hope that this memoir is but the first of a series to deal with the rich collections of Pontian mammals in the Museum—a hope that will be shared by all workers in this field. While the catalogue deals chiefly with the actual specimens in the Museum, due reference is made to types in foreign collections, so that the usefulness of the publication is enhanced. The bulk of the work is of course a descriptive account of the species, with their diagnostic characters and a list of the material, thus fulfilling the primary duty of a catalogue, but there is, in addition, a short introduction which gives information of the classification followed, and hints at some of the difficulties which are involved in the handling of incomplete material. There is a full and useful list of works consulted, and the illustrations are adequate.

No price is stated on this volume, as it is in some. It would be well to give this information as a uniform custom.

Dacia : an Outline of the Early Civilisations of the Carpatho-Danubian Countries. By Vasile Pârvan. Pp. xi+216+16 plates. (Cambridge : At the University Press, 1928.) 7*s*. 6*d*. net.

This little volume has been published as a permanent memorial of the late Prof. Pârvan's visit to Cambridge in 1926, when he delivered a short course of lectures on the civilisations of the Carpathian and Danubian countries. Himself a native of Moldavia, where he was born in 1882, he was imbued with " a strange instinct for its Latinity." Although he showed at an early age a high attainment in pure scholarship, he devoted himself with untiring energy to the prosecution of excavations in the little-explored regions of Rumania. Detailed accounts of the results achieved by himself and the school of young men whom he gathered around him were published in a periodical, *Dacia*, which he founded himself; but his most comprehensive account of Carpatho-Danubian archæology was published under the title " Getica." Of this work the present volume is in effect a summary, covering the period from the middle of the Bronze Age down to and including the intrusion of the Romans. For those who are unable to consult the larger work, which unfortunately has not been translated, this little book, dealing with an at present obscure subject, will be invaluable.

The Glands of Destiny (A Study of the Personality). By Dr. Ivo Geikie Cobb. Pp. vii+295. (London: William Heinemann (Medical Books), Ltd., 1927.) 7*s*. 6*d*. net.

The subject of this volume is of sufficiently intimate a character to command a wide circle of interest, especially as general as well as special terminology is used and a glossary is provided. The general reader will find much useful information and also much to interest him of a slightly speculative nature. A good case is made out for placing the factors which combine to form the ensemble connoted by the term ' personality ' on a more definite physiological basis rather than on a vague psychological elaboration.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

What Happens during an Electron Jump ?

THE Bohr theory showed its inadequacy most when the above question was asked. After describing the motion of an electron with minutest detail in all of its many orbits, a deafening silence answered him who inquired how the electron got from one orbit to another. The most one could say was that it suddenly disappeared, and simultaneously reappeared in an outer orbit, or vice versa.

Now, I believe the Schrödinger theory has implicitly tied up with it the answer to this question. Pauli's interpretation (cf. Jordan, *Z. Physik*, **40**, 811) that the expression

$$|\psi_{(q)}|^2 dq$$

represents the probability that the electron has a co-ordinate lying between the values q and $q+dq$ has led to the idea, permeating the quantum mechanics, that the electron, in tracing out its path, can go almost anywhere, but that the positions where it is most often found trace out the Bohr orbits. In other words, the electron orbit represents a cloud in space, the centre of gravity of which is the locus of a Bohr orbit. The Schrödinger condition, that ψ be finite throughout all of space, is then intelligible as meaning that the probability of the electron being at any position in space must be finite. If this is true, then what does the intensity rule for a spectral line mean in terms of this interpretation ?

It has been shown—can we say experimentally ?—that the intensity of a spectral line or the probability of a spontaneous electron jump, is proportional to the square of the matrix element,

$$q_{nm} = \frac{\int q\rho(x)\psi_n(x)\psi_m(x)dx}{\sqrt{\int\rho(x)[\psi_n(x)]^2dx . \int\rho(x)[\psi_m(x)]^2dx}}$$

(Schrödinger, *Ann. Physik*, **80**, 465; Born and Jordan, *Z. Physik*, **34**, 886). Let us disregard the denominator of this expression (introduced for normalisation purposes) and focus our attention on the product of ψ_n by ψ_m.

If an electron in state n happens to occupy a position x_1 at a certain time and can occupy that position x_1 with more or less probability while belonging to energy state m, then there is a probability of absorption of light, provided the photon comes along at that particular instant. If the same electron belonging to energy 'orbit' n occupies a different position, x_2, at, say, a different time and it could occupy that position x_2 just as well (more or less) while belonging to energy state m, then we have a greater likelihood of its absorbing a photon. For if the photon did not come along while the electron was at x_1, it might get there while the electron was at x_2. So the total probability of the electron undergoing a 'jump' will be the summation of the probabilities of the ability of the electron to occupy identical positions in the two states, over all the different positions it might occupy.

This leads us to the conclusion that in an electron 'jump,' *the electron does not jump*. It does not change its position. It does not disappear suddenly and reappear simultaneously in another place. At most, it undergoes a change in momentum and obeys a new force law, in much the same manner that a vibrating molecule behaves after absorbing light. According to the Franckian explanation (*Trans. Faraday Soc.*, **21**, 536) the nuclei vibrating about an equilibrium position r''_0 suddenly discover, immediately following the electronic excitation, that their equilibrium position is now no longer r''_0 but a different one (that is, r'_0) and so they have to vibrate according to the new law of force. In the case of an electron 'jump,' the electron suddenly experiences a momentum change by a Compton effect, and its natural motion thereafter is of a different type from what it was before the absorption of the photon because it has gained more kinetic energy.

I am well aware that I shall be criticised for discussing a phenomenon which, so far, is unmeasurable. But it seems to me this new interpretation of an electron transition removes the necessity for the tacit neglect of this most interesting question ; it hushes the accusation of inconsistency in physical theory, in this one particular at least ; it aids us in a more complete visualisation of atomic processes ; and, at the same time, it does not violate Heisenberg's uncertainty principle.

D. S. VILLARS.

University of Illinois,
Urbana, Ill., U.S.A.

The Boundary of the Solar Chromosphere.

IN analysing photographs of the flash spectrum it is customary to measure the lengths of the chromospheric arcs on the negative, and to deduce therefrom the heights to which various elements rise in the chromosphere. The H and K lines of calcium are always found to rise the highest, and their extent fixes the boundary between the chromosphere and the corona. One would very much like to know photometrically whether the intensity of H and K light is really falling off rapidly at this apparent boundary ; or whether it fades out slowly and extends appreciably beyond. Since 1897 the view seems to have prevailed that it does not. In that year Young wrote : "The photograph also seems to make it certain that hydrogen, helium, and calcium, though brilliantly conspicuous upon the plate in the images of the prominences, are *entirely absent from the corona*, a result agreeing with that deduced from similar photographs made in 1893, but only recently published. It is quite clear that the earlier observations (referred to on pages 261 and 262 of 'The Sun') were misleading from the fact that the apparatus did not sufficiently guard against the effects of illumination of the air by light from the prominences" (*Astrophysical Journal*, **6**, 155). By illumination of the air is meant scattering of light in the earth's atmosphere.

It is well known that the height to which spectral lines are observed to rise in photographs of the flash spectrum is often misleading, since the height depends on the intensity of the line. Of two lines arising from transitions from the same energy level of the same atom, the less intense may rise to only a small fraction of the height to which the stronger line is found to extend. The question arises : Is the apparent extent of the H and K lines any more trustworthy ? This problem has become important for the more detailed application of Milne's theory of support by radiation pressure.

The recent extension of Milne's theory by Taylor (*Monthly Notices R.A.S.*, **87**, 616; 1927) throws doubt on the reality of the apparent boundary of the calcium chromosphere, which all observations agree in placing at not more than 14,000 kilometres above the limb. On the contrary, the intensity of the H and K lines is now supposed to extend far beyond this limit, fading

out very slowly. Milne has accepted with approval this extension of his theory: "The spectral observations made by Col. Stratton and Mr. Davidson at the eclipse of 1926 (Sumatra) have been analysed by Mr. P. A. Taylor. He first extended the theory so as to allow for the curvature of the sun, and then compared the observed outward decrease in intensity of the flash spectrum with the calculated decrease. It appeared that all but about one ten-thousandth of the weight of the calcium chromosphere was supported by radiation pressure" (NATURE, **121,** 944; 1928). The same point of view seems to have been taken by McCrea in his further extension of the theory (*Monthly Notices R.A.S.*, **88,** 737; 1928). So it seems worth while to consider whether the sharpness of the apparent boundary can be illusory.

Visual measurements as well as photographic are possible for the height of the $H\alpha$ line. Some observations in full daylight were made by Fox (*Astrophys. J.*, **57,** 234; 1923); under unfavourable weather conditions he found a height of 7500 km., which agrees roughly with the height 8500 km. found from photographs of flash spectra. Observations of the H and K lines by photographic methods are more difficult, but a similar rough agreement is found.

Now, Kunz and Stebbins found that the brightness of the sky near the sun was 5000 times less intense during a total eclipse than in full daylight (actually 5300 times at the 1918 eclipse and 5500 at the 1925 eclipse. *Astrophys. J.*, **62,** 125; 1925); and it seems incredible that, when the chromosphere is viewed in daylight against a brighter background, roughly the same apparent limit should be found as in a total eclipse, unless there really is a rapid decrease in intensity at this boundary.

In addition to the photographs of the 1926 eclipse (*Mem. R.A.S.*, **64,** 105; 1927), on which Taylor based his conclusions, photographs were also taken in Sumatra simultaneously by Miller and Marriott (*Astr. Soc. Pacific*, **40,** 98; 1928). They state that on their photographs "strong H and K and hydrogen emission lines due to the scattering of light in the earth's atmosphere are superimposed upon the corona spectrum and extend into the lunar disc, but no Fraunhofer lines are seen on the disc, and only a slight suspicion of continuous spectrum." In the photographs of Davidson and Stratton the slit was tangential to the disc, instead of radial, so that the extension on to the disc was not observed and does not seem to have been taken into account. It is to be hoped that in the future it will be possible to make the difficult correction for scattering in the earth's atmosphere. In the meantime it would seem best to retain Young's conclusion quoted above, and suppose that the apparent boundary is real, with a rapid falling off in intensity. To obtain this result from Taylor's theory it may be only necessary to assume that about one thousandth of the weight of the chromosphere is supported by gravity, instead of one ten-thousandth.

RONALD W. GURNEY.
Mount Wilson Observatory,
California.

The Gamma Rays of Radium.

EXPERIMENTS which have been carried out here during the past few years lead to the following conclusions.

(1) The γ-rays filtered through 1·6 cm. of lead, and issuing from a hole in a lead block, have an average wave-length not greater than 0·0081 A. or a value of $\alpha = h\nu/mc^2$ not less than 3. For these γ-rays, using the usual nomenclature, $\sigma_a = \sigma_s$ approximately and not $1/2\sigma_s$, as is usually supposed.

The distribution of the scattered radiation is approximately that given by the Klein–Nishina formula (NATURE, vol. 122, p. 398; 1928) namely,

$$I_\theta = I\frac{e^4}{2m^2c^4r^2}\left\{\frac{1+\cos^2\theta}{(1+\alpha-\alpha\cos\theta)^3}+\frac{\alpha^2(1-\cos\theta)^2}{(1+\alpha-\alpha\cos\theta)^4}\right\},$$

the symbols having their usual significance.

From this formula we deduce that $\sigma_a = \sigma_s$ approximately, and also values of α which are within ten per cent of the values found by Gray and Cave (*Trans. Roy. Soc. Can.*, vol. 31, § 3, p. 7; 1927). This means that we may use their theory with some confidence in the interpretation of cosmic ray experiments.

(2) The Dirac theory of scattering is not correct. In the γ-ray region it leads to values of α which are much too small (compare Gray and Cave, loc. cit.), the corresponding recoil electrons having only one-third the required penetrating power.

(3) The ionisation produced, in a closed vessel, by rays of high frequency having a negligible photo-electric absorption coefficient τ, is approximately independent of the material of which the vessel is made. This assumes that the rays do not react with atomic nuclei.

(4) τ for hard γ-rays varies with a power of the wave-length much smaller than the 2·5th.

(5) The ionisation produced in a paper electroscope by γ-rays is increased by surrounding the electroscope completely by lead or brass two millimetres thick.

(6) The apparent absorption of an initially parallel beam of homogeneous γ-rays continually increases, presumably until a maximum is reached.

Making use of the above conclusions, an examination has been made of the results of cosmic ray experiments, and a further communication will be made later.

I feel that the method developed here four years ago for the determination of γ-ray wave-lengths has not been understood, doubtless because sufficient details have not been given. An outline of the method follows.

It is necessary to know:

(1) The penetrating power of the recoil electrons.
(2) The penetrating power of homogeneous β-rays.
(3) The distribution of scattered radiation, *i.e.* the variation of I_θ with θ.

It is assumed that the ionisation in a vessel of which the walls are of a substance of low atomic weight is produced by recoil electrons of energy E given by the equation

$$E = h\nu\frac{\alpha-\alpha\cos\theta}{1+\alpha-\alpha\cos\theta},$$

the radiation scattered at angle θ having a frequency ν_θ given by the equation $\nu_\theta = \nu/(1+\alpha-\alpha\cos\theta)$. If we write $I_\theta = F(\cos\theta)$, the number of quanta scattered between angles θ and $\theta + d\theta$ will be proportional to $F(\cos\theta)\ (1+\alpha-\alpha\cos\theta)\sin\theta\ d\theta$, and the number of electrons $N_E dE$ with energy between E and $E+dE$ to $F(\cos\theta)\ (1+\alpha-\alpha\cos\theta)^3\ dE$, since $\alpha\sin\theta\ d\theta = (1+\alpha-\alpha\cos\theta)^2\ dE$.

Relative values of N_E can then be obtained by putting $\cos\theta = 1$, 0·9, 0·8, etc., in the above expression for $N_E dE$, the corresponding values of E being found from the equation for E. This enables one to plot N_E against E. One must then allow for the fact that the smaller E is, the greater is the ionisation produced by a single electron. Making the necessary corrections, what may be termed I_E is obtained, $I_E dE$ being the ionisation produced by electrons with energy between E and $E+dE$.

I_E is then plotted against E, and a value of α is taken which will give the electrons as a whole the penetrating power found by experiment. As $\alpha = h/mc\lambda$ we can then find the wave-length λ.

It will be seen that from experiment (3), $F(\cos\theta)$

can be read directly from the curve obtained by plotting $F(\cos\theta)$ against θ. The problem, however, is simplified if we can find a formula, such as that of Klein and Nishina, which fits experimental results. An application of the method will be given later.

I have often found that work which it pleases me to think was of a pioneer character has been overlooked by other writers. I would like to emphasise the fact that most of the results given above follow directly from views developed here many years ago.

J. A. Gray.

Queen's University,
Kingston, Ontario, Dec. 26.

Some Aspects of Hæmolysis.

Many years ago, Sachs (*Biochem. Zeit.*, **12**, 278; 1908) showed that normal serum which ordinarily inhibits the hæmolysis of red blood corpuscles by soaps when present before the addition of the hæmolyte, accelerates this hæmolysis if it is added after the addition of the soap to the corpuscles. Later, Ponder (*Proc. Roy. Soc.*, B, **95**, 403; 1923) studied this phenomenon with taurocholate as the hæmolyte. In a recent paper we found (*Jour. Ind. Chem. Soc.*, 5, 261; 1928) that under the conditions of the experiment used by us, no acceleration of taurocholate hæmolysis could be observed irrespective of the manner of the addition of the serum, and Ponder suggested to us, in a private communication, that this was due to the particular conditions of our experiment, and that the acceleration could be observed under different conditions.

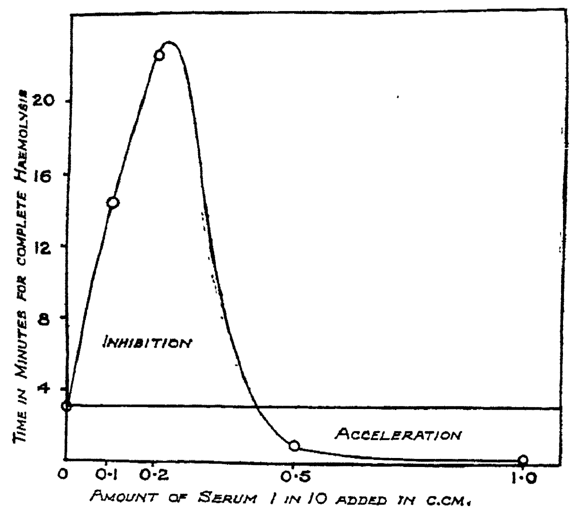

Fig. 1.—Effect of normal serum on a mixture of taurocholate and erythrocyte in isotonic saline.

We have now made a detailed study of the inhibition and acceleration of hæmolysis in presence of normal serum, and have observed that both acceleration and retardation of hæmolysis can be obtained easily in taurocholate and oleate hæmolysis by simply varying certain concentrations of the reacting substances. Since no one has yet published any data of similar nature, we desire to put on record the conclusions we have reached. In the accompanying curve (Fig. 1) we have plotted one set of results with varying amounts of serum. The quantity of the corpuscle, the total volume and the quantity of the sodium taurocholate were kept constant, but the amount of serum which was added to the cells half a minute after the addition of the taurocholate was varied. The abscissa represents the amount of serum, and the ordinate represents the time required for complete hæmolysis under otherwise identical conditions. A glance at the curve will show that we can get either an inhibition or an acceleration of hæmolysis when serum is added to a mixture of hæmolyte and corpuscle depending on the quantity of the serum.

We have also investigated the effect of the concentration of the corpuscles, of the amount of the hæmolyte added, and also the effect of the time-interval after which the serum is added, on the observed acceleration; and have found that all these factors are more or less important in showing this particular phenomenon. We have also found that normal serum is not the only substance which shows this acceleration phenomenon with oleate and taurocholate; a very dilute solution of alkali such as caustic soda can also show this behaviour with oleate and taurocholate, and we have been able to obtain almost similar curves with taurocholate and caustic soda. We consider, therefore, that in order to produce this acceleration phenomenon, it is not necessary to suppose any peculiar actions of the added serum proteins; because traces of pure alkali have been found to be equally effective, and the action of the normal serum may consist, at least in part, in changing the hydrogen ion concentration of the solution. We may add that this acceleration of hæmolysis by normal serum has been observed with taurocholate and oleate as the hæmolyte, but we have failed to get any acceleration with saponin.

K. C. Sen.
A. C. Ray.
N. N. Mitra.

Chemical Laboratory,
University of Allahabad.

Mechanism of the Swelling of Gels.

The problem of the swelling of gels has been the subject of a great deal of research, and still there does not appear to be any clear agreement between the views of different workers regarding the mechanism of the process. To take the case of gelatin, swelling is usually attributed to an osmotic action due to the presence of a soluble form of gelatin or its salt inside the molecular network of the gel. Recent work by myself (*Proc. Roy. Soc.*, A, **122**, p. 76; 1929) on the scattering of light in agar and gelatin sols and gels seems to indicate that these systems contain, to some extent at least, colloidal micelles which act as units. None of the existing theories says anything about the changes in these micelles during swelling. The object of the present note is to indicate the usefulness of light-scattering measurements in revealing these changes.

If a piece of gelatin be immersed in water it becomes opalescent as a result of swelling. This fact seems to have escaped the notice of previous investigators. The opalescence can be clearly noted when the swollen piece is viewed against a dark background. To find out the exact significance of this observation, it is necessary to determine the changes in light-scattering during swelling. The gel used in this investigation was obtained by drying a 2 per cent gel of $pH = 3$ in a suitable bottle. The results are given in the following table:

Wt. of gel.	Intensity of Scattered Light ($C_6H_6 = 1$).
3 gm.	67·7
5·64 ,,	73·3
7·86 ,,	67·6
12·54 ,,	48·9
16·40 ,,	42·9

It can be seen from the above data that the intensity of the scattered light increases at first and then diminishes as swelling proceeds.

These observations appear to me to provide a basis for the following picture of the mechanism of swelling: Swelling occurs as a result of imbibition of the solvent by the gel. We have to distinguish between two kinds of imbibition—one, in which the solvent is actually taken up inside the structure of the gel micelles. This part is held firmly by the molecules constituting the micelle owing to forces which are probably chemical in nature, and causes an increase in the volume of the micelles, and hence an increase in the light-scattering capacity of the gel. This process stops when a certain limit is reached, depending upon the cohesion between the molecules constituting the micelles. Secondly, the solvent which is still further taken into the gel remains in the intermicellary space, thus causing a dilution of the gel, and hence a diminution in its light-scattering capacity. This view is in complete harmony with the results obtained, and receives further support from the following observation:

A four per cent gelatin gel at the isoelectric point is very turbid. When this is dried in a desiccator, at first there is no change in the turbidity of the gel, but after a few weeks it commences to clear up from the top. As the dehydration proceeds, the whole gel becomes quite transparent by the time it shrinks to about two-thirds its original volume. This observation seems to be quite significant in that it shows definitely that the removal of the liquid in the earlier stages is not accompanied by any shrinkage of the micelles, while, later on, they do shrink, causing a very marked diminution in the light-scattering.

Further work on the changes in the scattering of light during the swelling of gelatin and other gels is in progress.

K. KRISHNAMURTI.
The Sir William Ramsay Laboratories of
Physical and Inorganic Chemistry,
University College, London.

Resistance of Wheat Varieties to Bunt (*Tilletia caries*).

A VARIETY of wheat, Sherman (*T. vulgare* Vill.), stated to be resistant to bunt, has been grown at Cambridge for the past five seasons. It has been tested for resistance or susceptibility to the fungus *Tilletia caries* (DC.) Tul. (=*T. tritici*). (Bjerk.) (Wint.). It was previously tested in 1923 at Moro. Ore. U.S.A., by the Cereal Investigation Board. The percentage of bunt then obtained was 1·1. In 1924–1926 it was very heavily contaminated by me at the rate of one part of crushed bunt balls to 25 parts of wheat. At the 1925 harvest, the percentage of bunt present was 1·01, at the 1926 harvest 1·6. It thus seemed evident that Sherman was very highly resistant to the disease.

In 1926 the wheat was re-sown and one-half of the seed was contaminated with Little Joss bunt and the other half with its own bunt, that is, Sherman bunt. At harvest in 1927 the percentage of bunt respectively in the two plots was as follows: Sherman with Little Joss bunt, 8·1 bunted ears; Sherman with Sherman bunt, 85·7 bunted ears. It is perhaps necessary to explain that the figure 8·1 is very high, having regard to the fact that the variety was contaminated with Little Joss bunt. The reason is probably that in hand-threshing the Sherman wheat it was slightly contaminated with its own bunt. Very often in apparently clean ears there is a bunted grain, especially in certain varieties. In threshing, the ears of clean Sherman wheat selected for propagation may have been accidentally contaminated in this way. The difference in the two cases, however, is so extremely great that the main conclusion is not obscured. In all cases the percentage of bunt was obtained by taking a count of a thousand ears, and the plots were sown the same day and under identical soil conditions.

Other wheat varieties, notably Ridit, Turkey, Hussar, and Berkeley Rock, known to be resistant to *T. caries*, have since been broken down by the same method of treatment. In one case Berkeley Rock was contaminated in 1927 with Little Joss bunt, and at harvest it produced 1·6 per cent of bunted ears only; contaminated with its own bunt it produced 91·1 per cent of bunted ears. In all cases the wheat was contaminated with spores until it was literally black, a spore load known to be sufficient to produce maximum infection.

In the same way that the plant breeder may select a unit from a population of a variety for resistance to a certain pathogen, so the destructive mycologist may select a pathogen from an analogous population to which a given host is susceptible.

Since the main results and conclusions of this investigation will not be published for some time, it is believed that this preliminary note upon the subject will be of value to workers engaged in the selection or hybridisation of wheat varieties for resistance to bunt.

W. A. R. DILLON WESTON.
School of Agriculture,
Cambridge.

Blue Rock Salt.

I WAS glad to learn from his interesting letter in NATURE of Jan. 26, p. 130, that Mr. F. C. Guthrie has verified our observations on the thermoluminescence of natural blue rock salt, which were published in the *Sitzungsberichte der Akademie der Wissenschaften in Wien* (II. *a*), **132**, 261, 1923, in collaboration with Miss M. Belar. Since then many samples of rock salt from various localities have passed through our hands, with the result that blue or violet pieces invariably show thermoluminescence, whilst colourless ones in general do not, only some very impure and opaque white pieces being an exception. It is scarcely to be doubted that the increased energy-content of the blue rock salt was acquired through absorption of some radiation, most likely of radioactive origin.

I would like to direct the attention of those interested in the subject to my two reports in the *Zeit. für Physik*, **20**, 196 (1923), and **41**, 833 (1927), on the work done in this Institute on the artificial and natural coloration of salts, and to my more recent communications to the Vienna Academy (*Wiener Ber.* (II. *a*), **136**, 43, 435, 679, 685; 1927: **137**, 409; 1928. *Wiener Anzeiger*, **274**, 1928; **8**, 1929) on this subject.

The results given in the last-mentioned note seem of more general physical, mineralogical, and technological interest, bearing, as they do, on the much-discussed question of recrystallisation, so I take the opportunity of stating the principal ones here explicitly: in pressed rock salt, which, as I have shown, turns rapidly black under radium radiation, and blue on subsequent exposure to daylight, there appear under prolonged radium treatment lighter yellow regions which expand from day to day. Cleavage in such regions shows the pressed salt to be perfectly recrystallised. There is definite evidence that the radiation not only offers a convenient way of showing the progress of recrystallisation, but also actually promotes it. These observations may give a clue to the explanation of some curious morphological details in natural blue rock salt, on which subject more will be said in a future communication to the Vienna Academy.

KARL PRZIBRAM.
Institut für Radiumforschung,
Vienna.

The Absorption Spectrum of Vitamin D.

With the assistance of Mr. R. G. C. Jenkins and Miss C. Fischmann, we have now fully confirmed the theory suggested previously that the ultra-violet irradiation of ergosterol produces three substances in succession (Webster and Bourdillon, *Biochem. J.*, **22**, 1223; 1928: *J. Soc. Chem. Ind.*, **47**, 1059; 1928). Of these, the first shows intense absorption for wave-lengths between 2500 A. and 2900 A., and great anti-rachitic power. The second shows intense absorption at 2400 A., and no antirachitic power. The final product (or products) has little or no appreciable absorption and no antirachitic power. We are now convinced that the first substance is vitamin D, for the following reasons:

(1) In a prolonged series of experiments we have studied solutions formed by the irradiation of ergosterol, under various conditions and in various solvents, and after removing the unchanged ergosterol (by treatment with digitonin) have measured the specific absorption between 2700 A. and 2900 A. and the antirachitic activity of these solutions. We have found satisfactory quantitative agreement between the two properties over a wide range, intense absorption being accompanied by great antirachitic activity, and solutions with smaller absorption showing correspondingly weaker activity.

(2) By further radiation of such solutions through a filter of alcoholic cobalt chloride (thus excluding radiation of wave-length less than 2600 A.), we have obtained solutions showing very slight absorption at 2700-2900 A., but intense absorption at 2400 A. These solutions showed no antirachitic activity when tested in doses which would have revealed one five-hundredth of the original activity.

T. A. Webster.
R. B. Bourdillon.

National Institute for Medical Research,
Hampstead, N.W.3,
Feb. 5.

Spectrum of Doubly Ionised Bromine.

Following the method of locating spectra by the horizontal comparison method described by Dr. Saha and Mr. Majumdar (*Indian Journal of Physics*, vol. 3, Part I.; 1928), I have been able to classify the spectrum lines of doubly ionised bromine. We take the series of elements As^{++}, Br^{++}, . . . Y^{++}; the spectrum lines due to the transitions $[xN_2(0_1 \longleftarrow 0_2)$, $x=0$ for As^{++} and 6 for $Y^{++}]$ have been obtained for As^{++} by Lang, and Y^{++} by Millikan and Bowen. From these it is quite easy to extrapolate the corresponding lines of Br^{++}. They were located at $\nu = 28000$ for the ${}^4PD$ group, and at 31000 for ${}^4P\overline{P}$ due to the transition $[2N_2(0_1 \longleftarrow 0_2)]$ of Br^{++}.

A strong group of lines in this region was obtained by Bloch and assigned to Br^{++}. I had not much difficulty in finding out the whole term system. Some of the lines are given; ${}^4P_2D_3$, 28063; ${}^4P_3\overline{P}_3$, 31497 and ${}^4P_2S_2$, 33096; ${}^2P_2{}^2\overline{P}_2$, 29995. In addition, the lines due to $2N_2(0_2 \longleftarrow 0_3)$ transition have also been obtained.

Suresh Chandra Deb.

Physical Laboratory,
Allahabad, Dec. 22.

Spectrum of Doubly Ionised Krypton.

The spectrum of doubly ionised krypton has been under examination by me for some time past. It seems evident that the strong group of lines about the wave-length 3250 belong to Kr^{++}. A preliminary attempt has revealed a number of regularities. I give below three sets of terms A, B, and C, which have so far been obtained. The strongest lines are obtained from the terms $A \longrightarrow B$, and probably represent the transition $3N_20_1 \longrightarrow 3N_20_2$. The other transition, $3N_20_2 \longrightarrow 3N_20_3$, etc., may appear as $B \longrightarrow C$.

A

0	716·6	2910·8	3346·2	3861·4
4968·9	4998·9	6122·8	8100·9	

B

30800·0	33360·2	33770·1	35187·6
35553·8	35857·6	35982·1	38407·6
38825·3	39795·6	40385·1	40418·1
40473·2	42741·7	43145·5	43602·9
	44122·6	45407·0	

C

64619·2	65807·2	68156·7	68240·5
69625·3	70519·0	75473·7	

I wish to record my heartiest thanks to Dr. P. K. Kichlu, who has always taken a kind interest in my work and has helped me with many valuable suggestions.

D. P. Acharya.

B.N. College, Patna,
Dec. 19.

Further Triplets of Trebly Ionised Arsenic (As IV).

Sawyer and Humphreys (*Phy. Rev.*, **32**, 580; 1928) have identified three triplets due to the combination of the term $4s4p\,{}^3P$ with $4s5s\,{}^3S$, $4s4d\,{}^3D$, and $4p^2\,{}^3P$ of the spectrum of trebly-ionised arsenic. In the course of the study of the spectrum of arsenic under different conditions of excitation, I have found two more triplets due to As IV, the details of which are as follows:

	λ.		ν.	Δν.
$5sS_1 - 5pP_2$	3109·01	(5)	32155·4	
$5sS_1 - 5pP_1$	3190·00	(3)	31338·9	816·5
$5sS_1 - 5pP_0$	3216·90	(2)	31076·9	262·0
$4dD_1 - 5pP_0$	2461·37	(3)	41615·5	261·7
$4dD_2 - 5pP_1$	2453·93	(4)	40738·6	138·6
$4dD_1 - 5pP_1$	2445·61	(1)	40877·2	816·3
$4dD_3 - 5pP_2$	2417·49	(5)	41352·6	202·3
$4dD_2 - 5pP_2$	2405·72	(2)	41554·9	
$4dD_1 - 5pP_2$	...		...	

Taking Sawyer and Humphreys' value, 199087 for $5sS_1$, the values of $5pP_{012}$ are 168010, 167748, 166932. The observed and calculated positions of the second triplet agree closely.

K. R. Rao.

Imperial College,
South Kensington, S.W.7.

Super-cooled Water.

The viscosity of water has been determined down to $-9°$ C., at which temperature it is quite fluid, and I was surprised to find that water drops suddenly chilled (without crystallisation) to $-17°$ became hard —that is, true water glass. In Beilby's "Aggregation and Flow of Solids" (1921), p. 195, we find: "When a small drop of water was placed on a glass slip which had previously been cooled to $-12°$ it instantly froze and became like a hemispherical lens, perfectly transparent and colourless. Under the microscope it showed no signs of crystalline structure. . . ." The term 'froze' is a little ambiguous, but from the context can only be taken to indicate hardening.

Thus there appears to be a great change in the properties of super-cooled water between $-9°$ and $-12°$. It seems unlikely that this phenomenon should have escaped notice up to now, but I can find no reference to it.

Leonard Hawkes.

Bedford College,
Regent's Park, N.W.1.

The Total Solar Eclipse of May 9.

On May 9 the sun will be totally eclipsed for a period up to more than five minutes in a belt which crosses land in Sumatra, Kedah, Siam, Cambodia, and the Philippines. The length of totality and the good field of stars in which the sun is placed at totality, make this eclipse one of the best for further examination of the law of displacement of stellar images through the bending of rays of light passing close to the sun. The value of the deviation predicted by Einstein was confirmed by the British observers in 1919, and by the Lick observers in 1922; but there have been indications of slight deviation from the formula proposed by Einstein for the displacements of the stellar images, and several expeditions are putting the Einstein experiment in the forefront of their programmes. The main subjects of other researches are spectrophotometry of chromosphere and corona, direct photography of the corona to examine structure and internal motion, interferometer observations for exact wave-lengths of coronal lines and rotation, photometry and studies of polarisation.

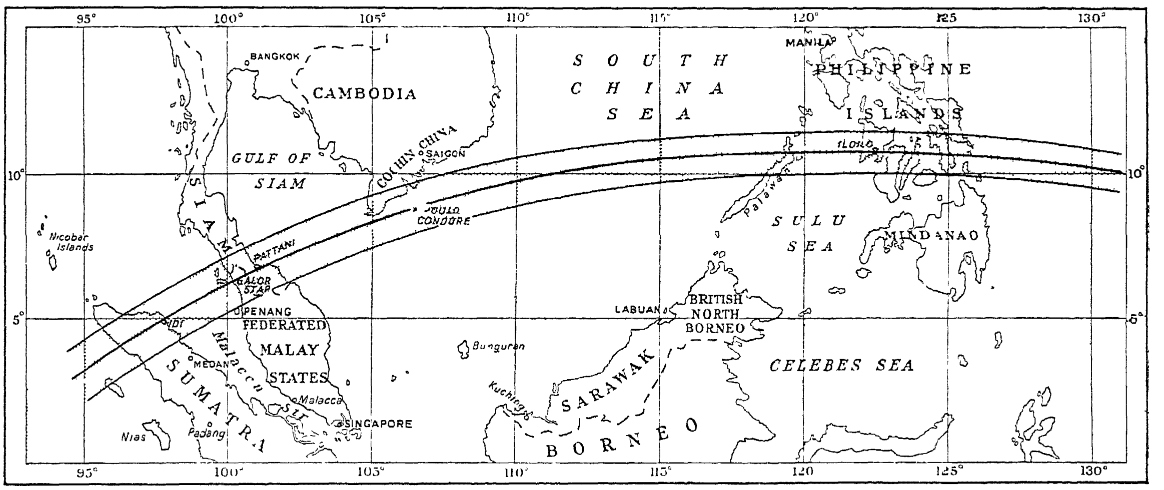

FIG. 1.—Track of total solar eclipse of May 9, 1929.

In Sumatra, which is to see a total solar eclipse for the third time this century, there will be two or three expeditions. A Dutch expedition, including Dr. Minnaert, who was successful in Sweden in 1927, will probably go to the north-east coast near Idi. They will study the solar radiation near and through totality, and the spectrophotometry of the chromosphere and corona. The party may be joined by a German expedition from Potsdam, which will attack the Einstein problem with an astrographic telescope and also with a cœlostat with two camera tubes—taken out to Sumatra by Dr. Freundlich in 1926. The German expedition will also aim at securing improved wave-lengths for the coronal lines by using a spectrograph of high dispersion and will work on the relative intensities of these lines. An American expedition under Prof. Miller, of Swarthmore College Observatory, will also attack the Einstein problem, will take a number of direct photographs with a tower telescope of 62 ft. focal length for coronal structure, and will try for exact wave-lengths of the corona by the use of an interferometer. This expedition will probably be at or near Idi on the north-east coast of Sumatra.

In Kedah, a Malayan State, there will be a British expedition, probably at Alor Star. Dr. Jackson, of the Royal Observatory, Greenwich, will carry out the Einstein experiment with a cœlostat feeding a 7-inch lens of 21-ft. focal length, while Dr. Carroll and Dr. Aston, from Cambridge, will work on spectrophotometry with a moving plate spectrograph and on motion in the corona by means of an interferometer, applying the method used on the Orion nebula by Fabry and Buisson. Direct photography of the corona with a 6-inch lens of 45 ft. focus, and through colour screens with short focus cameras, will also be carried out.

The other British expedition—Prof. Stratton, of Cambridge, with Mr. Melotte, of Greenwich—will repeat the study of the relative intensity of the H and K lines and the infra-red triplet of ionised calcium by means of a Littrow grating spectroscope, in order to test Milne's theory of the chromosphere, and will also repeat the Einstein experiment, using the Greenwich astrographic telescope and the mounting prepared for the Christmas Island eclipse of 1922. Direct photographs of the corona will be made with the 4-in. lens of 19-ft. focal length belonging to the Royal Irish Academy but used at a succession of eclipses, and the flash spectrum will be obtained with this instrument and with a direct-vision prism lent by the Royal Observatory, Edinburgh. In addition, a polariscopic study of the corona will be made with the Nicol prism used in the past by Prof. Newall. Dr. Royds, of Kodaikanal Observatory, Profs. Kibble and Barnes, of Madras, Col. J. Waley Cohen and Mr. E. G. Barton are expected to join this party. The last-named has been travelling in China and Burma since the

eclipse of 1926, where he was a member of the British Expedition to Benkoelen.

In Kedah or Siam there will probably also be an American expedition from Harvard, Prof. Stetson and Mr. Weld Arnold, with a programme of photometry—absolute and relative—and direct photography of the corona; and near Khoke Bhode, in Siam, there may also be a German expedition from Kiel and Göttingen. Their programme will include photometry and spectrophotometry of the chromosphere and corona and a search for faint coronal lines with a spectrograph of high light-gathering power.

On Poulo Condore, an island off the coast of Cambodia, there will be a French expedition from the Bureau des Longitudes. Coronal photometry and the Einstein experiment will form the main programme. At Iloilo, in the Philippines, a German expedition from Hamburg will be established with a programme including objective prism flash spectra and direct photography of the corona with a series of exposures of different lengths. It is possible that Anderson's apparatus may also be taken to the Philippines by a joint American and Norwegian expedition, mainly from the Naval Observatory, Washington.

The weather prospects along the whole belt are reasonably good, and with so many parties so well spaced along the belt of totality, it may be hoped that important results will be obtained in the whole field of eclipse problems of present-day interest.

The Structure of Atomic Nuclei.

In opening the discussion on atomic nuclei, held at the Royal Society meeting on Feb. 7, the president, Sir Ernest Rutherford, directed attention to a former meeting, held at the Royal Society in March 1914, when the existing evidence on the nuclear structure of the atom was set out. The speakers at that meeting included the president as opener of the discussion, Moseley, Soddy, Nicholson, Hicks, H. S. Allen, and Sylvanus Thompson. It is of interest to note that at this meeting Moseley gave his final conclusion on the classification of the elements by their ordinal numbers, and that Soddy, after giving the evidence for the existence of radioactive isotopes, suggested that many of the ordinary elements might also consist of isotopes, a result so completely confirmed in later years.

The experiments described at that meeting in 1914 tended to show that the nucleus was to be regarded as a point, but in the intervening years evidence from a variety of sources has been accumulated which throws light on the structure of this minute central body. Sir Ernest directed attention to the three main lines of attack: the measurements of the masses of atoms, the evidence from collisions of α-particles with nuclei, and the evidence provided by the natural disintegration of the radioactive elements. He emphasised that, while many nuclear phenomena have been observed and investigated in the last decade, only one way of influencing the nucleus directly has been discovered. Although many attempts have been made to disintegrate the elements artificially, the only agents which have as yet accomplished this are the α-particles emitted by radioactive bodies. The α-particles are helium nuclei with energies as high as seven million electron-volts, and, when their direction of impact on an atom is central, they can penetrate the atom and collide with the nucleus, thereby disintegrating it.

One of the most fruitful lines of investigation has proved to be the observation of the deflection α-particles suffer when they pass near the nucleus but yet do not disintegrate it. This scattering, as it is termed, is due to the electrical forces between the α-particle with two elementary charges, and the nucleus with Z elementary charges, where Z is the atomic number. The α-particles which penetrate closest to the nucleus are most deflected, so that conversely by observing the relative number of particles deflected at a certain angle, information can be obtained about the electrical forces between the particles for a definite distance of approach. It can be shown that the variation of the scattering at a definite angle as the velocity of the particle is changed gives direct information on the rate of variation of the electrical forces with distance.

An extended series of experiments on these lines has been made by Rutherford and Chadwick, and the results have shown that for the elements from copper (atomic number 29) to uranium (atomic number 92), the law of force is that of the inverse square. The closest distance of approach of the particles to the nucleus in these experiments was 10^{-12} cm. in the case of copper, and about 4×10^{-12} cm. with uranium. The fact that no deviations from the inverse square were found indicates that for these distances of approach the two charged bodies are acting as points, and no information can be deduced about the dimensions of the nucleus except that it must be smaller than these distances. With lighter elements quite different results are obtained. Owing to the smaller nuclear charges, the α-particle can approach much nearer to the nucleus and marked deviations from the scattering expected on the inverse square law are observed. The most natural explanation of the results is found to be that, at very close distances, attractive forces come into play varying rapidly with the distance. The experiments are not as yet sufficiently definite to determine the rate of variation in detail. Debye and Hardmeier have attempted to put the existence of these forces on a physical basis by suggesting they are due to distortion or the mutual polarisation of the colliding particles. It appears that this hypothesis can give a general explanation of the scattering by light elements.

An extremely important application of these scattering experiments is obtained by considering the results with uranium. On ordinary views, part at least of the energy of the α-particle ejected from the uranium nucleus must be due to the repul-

sion of the inverse square law forces. If its entire energy is attributed to this cause, a minimum estimate will be obtained for the distance at which the inverse square force of repulsion begins to be appreciably diminished by the attractive forces. The calculation yields a value of 6×10^{-12} cm.; this is in complete disagreement with the scattering result already quoted, which showed that the inverse square field extended down to a distance of less than 4×10^{-12} cm. This impasse is avoided if we may make use of the wave-mechanics.

Dr. J. Chadwick described a similar phenomenon which is found to occur with aluminium, which is almost at the other end of the table of elements. Aluminium is one of the elements which can be disintegrated by the impact of α-particles, and, as would be expected, the probability of disintegration decreases as the speed of the α-particle is decreased. Measurable disintegration, however, is still observed with α-particles of such low speed that the scattering observed in other experiments is still due to inverse square law forces. In one experiment, α-particles of this speed appear to be able to hit the nucleus so as to disintegrate it, but yet in the other the same speed α-particles are deflected as if the nucleus acted as a point charge.

Both these results can be explained at least qualitatively, according to the wave-mechanics, in a manner suggested independently by Gurney and Condon, and by Gamow. It is supposed that the repulsive inverse square law field surrounding the nucleus extends down to very small distances, of the order of $0{\cdot}7 \times 10^{-12}$ cm. for uranium, and rises to a peak value of the order of thirty million volts. The scattering results are therefore directly understandable. The reason why a slow particle can escape from the uranium nucleus, or in the other case penetrate into the aluminium nucleus, is to be sought for in the peculiar properties ascribed to particles by the wave-mechanics. On the classical theories, the only way a particle can pass from one region into a second separated from the first by a potential barrier is by surmounting the barrier. On the wave-theory, however, there is a finite probability of the particle passing through the potential barrier although its energy may be far less than the peak value.

Several points of exceptional interest have been discovered in connexion with the artificial disintegration of the elements. With the exception of lithium, beryllium, carbon, and oxygen, all the elements up to potassium can be disintegrated by the α-particles of radium-C (energy seven million electron volts). Particular attention had been directed to the energy relations occurring in the collision. For example, it is found that protons are knocked off the aluminium nucleus with energies as high as $1{\cdot}4$ times that of the incident α-particle. The experiments of Blackett have shown that in the process of artificial disintegration of nitrogen, while a proton is knocked off, the α-particle appears to be captured. If this is also the case in the disintegration of aluminium, it is possible to deduce from the experiments that what may be termed the heat of the reaction is not constant, but varies over a comparatively wide range. The obvious suggestion is that the masses of all aluminium nuclei are not identical.

The elements of odd atomic number give protons of greater range than those of even atomic number, and this distinction between the two classes was emphasised by Dr. F. W. Aston in connexion with his experiments on the isotopic constitution and masses of the elements. While the even atomic numbers often have many isotopes (tin has eleven), the elements of odd atomic number appear never to have more than two.

Valuable evidence on the stability of the elements is provided by the accurate measurements of their masses by the mass-spectrograph. The mass of a nucleus is in general found to be less than the sum of the masses of the protons, α-particles, and electrons of which it is supposed to be constituted. This disappearance of mass represents an emission of energy in its formation, or conversely, that energy must be supplied to disintegrate it. The measurements so far carried out support both the results on the artificial disintegration and the occurrence of natural disintegration for elements of high atomic number. For example, with the radioactive elements it appears likely, as was pointed out by Sir Ernest Rutherford, that the α-particle has more mass inside the nucleus than when it is free.

Mr. R. H. Fowler gave an account of the developments of Gamow's theory, which has already been referred to. It has been seen how the experimental evidence leads to the conception of attractive forces at close distances giving rise to a potential barrier surrounding the nucleus as shown in Fig. 1. The problem is how constituents of

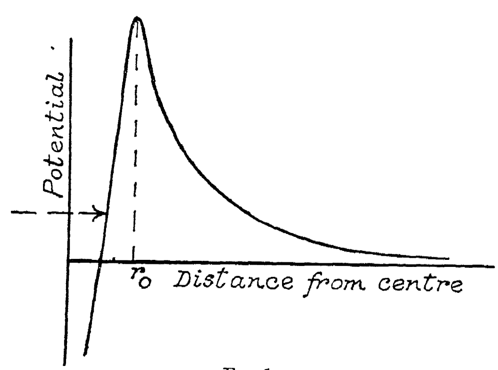

FIG. 1.

the nucleus such as α-particles which are inside this nucleus can escape, when their energy as represented by the arrow is insufficient to take them over the peak. An α-particle inside such a nucleus is not to be considered as a material particle executing some kind of orbital motion, but as a wave motion filling the whole of the space. The wavelength is determined by the momentum of the α-particle, and as a rough illustration, the stable states are those in which some type of stationary wave system exists. If the potential barrier were infinitely thick or high, it would be possible to have a true stationary wave motion and the

system would be permanently stable. With a finite barrier, the wave motion on the new mechanics is found to be a damped vibration coupled with an issuing wave which penetrates the barrier. The exact optical analogy is a wave incident at an angle greater than the critical angle on a surface only a few wave-lengths thick. In this case it has been shown experimentally that a small amount of the wave penetrates the surface. The issuing wave in the nuclear problem must be interpreted as showing that the α-particle has a possibly small, but yet finite chance of escape from the system with the same energy that it has inside the nucleus. This is in itself the explanation of radioactive disintegration, but the calculation can be pushed much further. It will be seen from Fig. 1 that the greater the energy of the α-particle the smaller the thickness and height of the potential barrier it has to penetrate, and the greater should be the chance of escape, that is, disintegration. This is the well-known Geiger-Nuttall law connecting the energy of the ejected α-particle with the transformation constant. Considering the provisional state of the theory, an excellent quantitative account can be given of the observed connexion between the energies of the α-particles and the transformation constants. The distance r_0, about $0{\cdot}7 \times 10^{-12}$ cm. for heavy nuclei, may be looked on as the size of the nucleus, and it is found necessary to allow this to decrease as we go down the series. This is, of course, reasonable.

It has as yet not been possible to include the nuclear electrons in this theory, or to attempt an account of the β- and γ-ray phenomena. The evidence on this subject was described by Dr. C. D. Ellis. The γ-rays are high frequency electromagnetic radiations emitted immediately after the departure of the disintegration particle and can be considered as the result of the adjustment of the nucleus to the new conditions. They constitute the characteristic spectrum of the nucleus and will no doubt provide valuable information on its structure, but at present there is difficulty in deciding how they are emitted. It appears unlikely that they can be emitted by electrons, but there is still the choice between the positive particles and the nucleus as a whole by some process such as rotation. There is clear evidence that the γ-rays can be associated with a level system, and while it may be difficult to fix the system from pure energy considerations, measurements of the intensities should enable a decision to be reached.

A phenomenon indicating a coupling between the nucleus and the outer electronic structure has been observed by G. H. Aston and Ellis. The energy of the excited nucleus is not always emitted in the form of radiation; it is sometimes converted inside the same atom and leads to the ejection of an electron from the atom. If the probability of this happening were to vary smoothly with the frequency, the process would be similar to the actual emission of the energy from the nucleus and reabsorption by the electrons. The two systems cannot be considered distinct in this way, since the probability of conversion is found to oscillate rapidly in ascending the scale of frequencies.

Prof. O. W. Richardson pointed out that spectroscopic evidence has an important bearing on the question whether the nucleus is in rotation. He described an *a priori* argument which makes it probable that the nuclei of the elements must in many instances be rotating. In the case of hydrogen, the result of this argument is almost a certainty. A universe is imagined which at a certain instant consists of one electron and one proton, and these unite to form an unexcited hydrogen atom with the emission of radiation. The spectroscopic evidence is overwhelming that in the ground state of an atom each extra-nuclear electron has half a quantum of angular rotation. If the postulated universe is to obey the principle of the conservation of angular momentum, the nucleus of the hydrogen atom must have acquired half a quantum of angular momentum in the opposite sense. An improbable but interesting alternative is that the emitted radiation preserves the conservation of momentum by having a sufficiently high degree of elliptical polarisation.

There is good spectroscopic evidence that the nuclei of a number of elements are rotating and have a quantised angular momentum. This is shown from the magnetic field resulting from this rotation, which causes the hyper-fine structure of the spectral lines of many atoms. A sufficient analysis has already been made for bismuth and cæsium to indicate the exact number of quanta on the nucleus. The spectroscopic evidence of the alternating intensities in the band spectrum of hydrogen, and the specific heat of hydrogen gas, when interpreted according to the wave-mechanics, also definitely require the proton to have half a quantum of angular momentum.

Obituary.

DR. H. J. H. FENTON, F.R.S.

THE death of Dr. H. J. H. Fenton, formerly lecturer and demonstrator of chemistry in the University of Cambridge, will be regretted by many generations of Cambridge men, for he taught in the University for more than forty years, and of the numbers that have attended his lectures there can be few who did not receive a lasting impression from his teaching.

Henry John Horstmann Fenton was born at Ealing in 1854. After having been educated at Magdalen College School, Oxford, he went to King's College, London, where he studied chemistry under Bloxam, and at the end of his course acted as demonstrator. About this time the Clothworkers' Company instituted an exhibition in physical science tenable for three years by a non-collegiate student at Cambridge. The first award

of this exhibition was made to Fenton, and he entered the University of Cambridge in the Lent Term, 1875. He afterwards gained an entrance scholarship at Christ's College, where he was admitted in May 1876. After the relative freedom of his London course he chafed at the discipline then imposed on undergraduates, with the result that he not infrequently came into conflict with university and college authorities. He took the Natural Sciences Tripos in 1877, and was placed in the first class; among his contemporaries placed with him in this class were Adam Sedgwick the zoologist, Bower the botanist, and Alex Hill, afterwards master of Downing.

Fenton was soon appointed an assistant demonstrator by Liveing, and when the then University demonstrator of chemistry, John Wale Hicks, of Sidney Sussex, afterwards Bishop of Bloemfontein, retired, W. J. Sell was appointed to succeed him, and an additional demonstratorship of chemistry was instituted by the University and the post assigned to Fenton.

This was in the days of the old Chemical Laboratory, which stood on the east side of the site of the former Botanic Garden and afterwards served as part of the Pathological Laboratory. Several of the colleges then had their own chemical laboratories, and these were run in competition with the University laboratory. This competition continued for many years after the erection in 1887 of the new University Chemical Laboratory in Pembroke Street, though in an ever-lessening degree as the college laboratories one by one were given up. The greater part of the teaching in the University laboratory was carried out by Sell and Fenton, and in spite of their different temperaments the two men worked together in harmony until their association was terminated by the death of Sell in 1915.

Fenton's lectures were for many years an outstanding feature in the instruction given in the University Laboratory. He took immense pains in their preparation, and although in lecturing he affected an air of boredom and a somewhat indolent manner, actually he delivered them with very great care, and he was extraordinarily successful in stimulating the interest of the abler men. He was scrupulous in avoiding dogmatism, and he endeavoured, so far as possible, to present every subject as a debatable question on which there were diverse views to be discussed. The value of his lectures was greatly enhanced by the informal discussions which he encouraged; at the close of every lecture a number of eager young men would come down to the lecture table and discuss with him, often for half an hour or more, the questions in which he had aroused their interest.

The course of experimental work in general and physical chemistry which Fenton devised to illustrate his lectures was very carefully thought out, and during the 'eighties, and even later, the type of laboratory work being done by his class was probably unique. Of his books, his "Notes on Qualitative Analysis," which was widely used, and his "Outlines of Chemistry," of which Part I. only was published, are best known.

Although Fenton's chief interest always seemed to lie in general and physical chemistry, the greater part of his original work was carried out in organic chemistry and his most important investigations centred round dihydroxymaleic acid. He was led to the discovery of this compound in a curious way; whilst demonstrating one day he found that a student amusing himself by mixing a number of reagents selected at random had obtained a remarkable purple coloration. Fenton realised at once that the observation was one that should be followed up, and he found that the colour was due to the iron derivative of an oxidation product of tartaric acid. Several years later he succeeded in the difficult task of isolating this product, and showed that it was the previously unknown compound, dihydroxymaleic acid. In a series of elegant investigations, carried out in part with the assistance of his students, he described numerous interesting transformations of this substance, and also established the value of hydrogen peroxide in the presence of iron salts as an oxidising agent.

Fenton was elected into the Royal Society in 1899, and served on the Council of that body from 1913 until 1916. He was made an honorary fellow of his College in 1911. He was naturally a shy man and was exceedingly sensitive to chaff or criticism; he endeavoured to conceal his shyness by assuming a certain *hauteur* which tended to repel some of those who would have sought his friendship. He had a very strong sense of fairness, but his pertinacity in defending views in which he was in a minority of one sometimes made him a difficult member of University bodies. He married in 1892, Edith, daughter of George Fergusson of Richmond. He left no children. He gave up his lectureship in 1924 and went to live at Hove, but the last years of his life were greatly clouded by illness. He died in a nursing home in London on Jan. 13, at the age of seventy-four.

C. T. H.
W. H. M.

PROF. R. H. YAPP.

WE regret to record the death on Jan. 22 of R. H. Yapp, Mason professor of botany in the University of Birmingham, after a year of suffering borne with heroic fortitude and patience. His untimely death at fifty-seven years of age is all the more tragic as the new and extensive laboratories, which he had planned with such care and thoroughness, had only just been opened before he was taken seriously ill, and he was thus unable to complete a number of investigations which had been temporarily laid aside for the exacting duty of supervising the erection of the greatly needed new department.

Richard Henry Yapp was born in the village of Orleton, in Herefordshire, in 1871, and was educated at a school in Hereford, and later at Nottingham. After spending some years in the firm of Messrs. Alexander and Duncan in Leominster, he entered St. John's College, Cambridge, as a scholar, and graduated with first class honours in botany in 1898. Elected to the Frank Smart Studentship

at Gonville and Caius in 1899, he was appointed botanist to the University of Cambridge scientific expedition to the Malay States under the leadership of Mr. W. Skeat. Of the interest aroused in him by this expedition he always spoke with warm recollection, and the material collected formed the basis of several investigations published in the *Annals of Botany*.

In 1904, Yapp was appointed to the chair of botany in University College, Aberystwyth, and during the ten years of his tenure of that professorship he reorganised and extended the botanical department, and enriched its museum with many specimens collected in the Malay States and in South Africa, during his visit to that country with the British Association in 1905. From Aberystwyth, Yapp went to Queen's College, Belfast, and in 1919 to the University of Birmingham. In all three places he threw himself with vigour into the teaching and reorganising of his department, and by his active interest in the general welfare of the college or university to which he was attached, he invariably gained the confidence and esteem of his colleagues, and was trusted as a clear-sighted adviser. Though this brought him many and exacting duties, he managed to accomplish a considerable amount of research work which was latterly of a physiological and ecological nature.

While still at Cambridge, Yapp had become interested in the fens, and spent many holidays studying the peculiarities of their vegetation. As a result of these studies he published a detailed account of the vegetation of Wicken Fen, dealing more particularly with the relation of the plants to soil moisture. This was followed by a critical account, structural, physiological, and developmental, of the foliage of the meadow-sweet (*Spirea Ulmaria*), as bearing on the problem of xeromorphy in marsh plants. In this question of the water-relation of plants his interest continued to the very end, and during his last illness he was busy editing the English translation of Prof. Maximov's book on this subject, and also writing up voluminous notes of investigations carried out by himself some few years ago.

While at Aberystwyth, Prof. Yapp became interested in the various plant associations of the Dovey estuary, and made a special study of the vegetation of the salt marshes. Detailed accounts of this investigation were published in the *Journal of Ecology* in 1917 and 1921. These ecological studies necessitated the consideration of the general inter-relationships of plants in vegetation, and led to the publication of two critical papers on the "Concept of Association" and the "Concept of Habitat" respectively. Had he been spared to work out other important ideas for which he was collecting evidence, Prof. Yapp would have still further enhanced his reputation as a careful observer and a clear thinker. In recognition of his ecological work he was elected president of the Ecological Society in 1921, and he was looking forward with eagerness to presiding over the botanical section of the British Association at the meeting in Glasgow last autumn, when his fatal illness necessitated his resigning the presidency of the section. Though aware of the probable fatal termination of his illness, he never lost courage, and continued as long as it was possible to work at the completion of some of his botanical investigations.

Yapp possessed a clear and orderly mind, and had the ability to present lucidly and tersely the information he wished to convey. Good evidence of this is afforded not only by his published researches, but also by the success of his small text-book on botany published by the Cambridge University Press. He leaves a widow, who tended him with touching devotion during his prolonged and painful illness, and two children, a son and daughter. By his death the University of Birmingham loses a valued teacher, and science an ardent investigator and a gifted botanist. His botanical colleagues will remember him as a genial friend, of innate modesty and of singular personal charm.

FRÄULEIN GERDA LASKI.

FRÄULEIN GERDA LASKI, who was one of the few women to succeed in making a name for herself in the realms of the exact sciences, died in Berlin on Nov. 24. Coming of a well-to-do family in Vienna, her attention was liberally directed from the first towards the arts and sciences, a fact which, combined with a natural vivacity and affectionate temperament, endowed her with great versatility, and added in no small degree to the charm of her personality.

Fräulein Laski studied for her doctorate in Vienna at the Physical Institute under Prof. Ehrenhaft, and her first published work—on submicroscopic particles—was a direct result of the intellectual circle in which she was placed. After a period at Göttingen (where Debye then was) she became assistant in the Physical Institute of the University of Berlin, where she was introduced by Rubens to the experimental technique of infra-red research. This subject had attracted her during her sojourn in Göttingen, and, broadly speaking, it remained her chief interest to the end. In 1924, Fräulein Laski was chosen to take charge of the department of infra-red research in the Kaiser Wilhelm Institute für Faserstoffchemie at Dahlem.

In addition to various publications dealing with her own investigations (such as the long wave-length spectrum of mercury vapour, the infra-red spectra of chlorates and bromates, and of cellulose), Fräulein Laski contributed the article on infra-red research to vol. 3 (1924) of the "Ergebnisse der exakten Naturwissenschaften." Her last work comprised a couple of chapters, "Special Methods for Measurements in the Infra-red" and "Thermo-electricity" for the Geiger-Scheel "Handbuch der Physik."

Fräulein Laski's death while in the prime of life has removed a talented research worker, and at the same time many will regret the passing of a colleague who had endeared herself to a wide circle of friends.

News and Views.

Meteorological statistics justify, on the whole, the selection of Aldwick, near Bognor, as the place of convalescence for His Majesty the King, when it is borne in mind that sunshine is the element of greatest importance in such a case. Bognor lies within the only strip of the south coast of England where the general average daily duration of sunshine in the month of February exceeds three hours. The contrast between the figures for this Sussex watering-place and those for St. James's Park are most striking for mid-winter, but even in this month, with its lengthening days, the relative amounts are not far short of three to one. In March the ratio is reduced to almost exactly two to one, and by April the advantage of the seaside place is reduced to 45 per cent. The particular merit of the climate of the Sussex coast is that it combines a low average rainfall with its abundant sunshine, and in this respect has a great advantage over the southern coasts of Devon and Cornwall. On the other hand, the south-west coast has a slightly higher mean temperature, due to the fact that it is more frequently under the influence of the mild southerly or south-westerly winds of the Atlantic, at the same time that the south-east of England is meteorologically one with the Continent during a spell of the cold easterly type of weather. A curious fact—perhaps not widely recognised—is that in spring the warmth derived from artificial sources in London on the one hand, and the influence of the cold sea upon the coastal climate on the other, are sufficient to make St. James's Park actually warmer than Bognor when shade temperature alone is considered. The difference amounts to about a degree and a half.

Central Europe is in the grip of an intense anticyclone, and over northern Russia pressure exceeds 1044 millibars, which is 30 millibars above the normal for the month. Usually during February the axis of high pressure lies to the south, over Switzerland and the Balkan highlands, and the greater part of Europe comes under the influence of rather mild westerly and south-westerly winds from the Atlantic. Under the conditions existing at present, however, pressure is highest in the latitude of the Baltic, and winds are easterly over almost the whole of Europe, from the Black Sea and the Alps to the North German coast. The anticyclone is an offshoot of the great winter anticyclone of Siberia, and the source of the air is away in central Asia. Reports in the press quote some extraordinarily low temperatures, such as $-67°$ F. at Ivanov-Voznesensk, north-east of Moscow, and perhaps even lower at other places in central Russia, $-40°$ F. near Vilna in Poland, $-31°$ F. in Silesia, $-24°$ F. in Belgrade, and $-15°$ F. in Berlin. The last, if correct, is the lowest temperature recorded during more than a hundred years' observations in that city, the previous lowest having been $-13°$ F. in 1850 and 1855.

The lowest temperatures hitherto recorded near Moscow are probably not below $-50°$ F., and the low minima quoted above are not confirmed by figures in the *Daily Weather Report*. The western Baltic is freezing, and many ships are fast in the ice. Vienna is also intensely cold, and the Danube is frozen for 1200 miles. The cold extends across south-eastern Europe to Asia Minor and Syria, and there have been several heavy falls of snow in the Balkans, associated with a deep depression which occupied the eastern Mediterranean at the end of January and beginning of February. The deep drifts have blocked the railway line to Constantinople, and three Simplon express trains with a number of passengers have been snowed up for a week in Thrace.

In response to the invitation of the Royal Institution, representatives of many scientific and technical societies met in the famous lecture theatre in Albemarle Street on Feb. 5, to consider the preliminary arrangements for the celebration of the centenary of Faraday's great discovery of electromagnetic induction, which he made on Aug. 28, 1831. Sir Arthur Keith was in the chair, and in opening the proceedings reminded those present that the Royal Institution was not only the scene of Faraday's labours, but it was also for more than half a century his home. Sir William Bragg, director of the Royal Institution, said that the proposed celebrations had been in mind a long time, and in choosing the particular discovery of August 1831 they were recalling one of Faraday's most important discoveries, on which rested a vast body of scientific and industrial development. The occasion would give the nation an opportunity of realising the contributions to science and industry during the last hundred years. It was unlikely there would be another occasion so favourable, and if made a success, the centenary would encourage the people to go on with their work and brighten the whole outlook of the nation.

Among the speakers was Sir Ernest Rutherford, who not only approved the suggestions but also pointed out that in 1931 occurs the centenary of the birth of James Clerk Maxwell, who in a sense was Faraday's interpreter and put into mathematical form the latter's views. Col. K. Edgcumbe, president of the Institution of Electrical Engineers, Sir John Snell, Sir William Pope, Mr. D. N. Dunlop, Sir John Reith, Col. W. A. Vignoles, and Prof. J. L. Myres all promised the co-operation of the societies they represented. Prof. Myres made the interesting announcement that the officers of the British Association were prepared to recommend to their Council that the centenary meetings of the Association of 1931 should be held in London, and said they would be glad to do everything in their power to ensure that not only the intellectual descendants of Faraday himself, but also the large public interests which benefited from the applications of those discoveries, should be represented. The meeting approved the appointment of two small committees to deal with the scientific and industrial sides of the celebration, which Sir William Bragg announced would probably take place in the third week of September 1931.

Two donors, who desire to remain anonymous, have each presented the London Hospital with a gram of radium for work on cancer. Following so soon after the generous gift of radium to the King Edward Hospital Fund by Sir Otto Beit, these gifts are adequate testimony to the conviction that is gaining ground of the good results which follow the use of radium in the treatment of cancer. Conditions were laid down by Sir Otto Beit that his radium should be loaned to centres where the study of radiation questions is carried out on scientific lines. One of the London Hospital donors has supplemented his gift by an additional £13,000, which is to be invested and the income from it used in running a radium laboratory. The radium and the endowment are to form a trust known as the Freedom Radium Trust, and this Trust is to be managed by a committee of three 'governors,' who have power to co-opt members of the honorary surgical staff. The number of cancer cases treated at the London Hospital is 800-1000 a year, and steps are being taken for complete records of all the cases which will be treated under these new opportunities.

A PROJECT to perpetuate the memory of the late Drs. Peach and Horne has been recently inaugurated in Edinburgh. Benjamin Neeve Peach died in January 1926, and his lifelong friend and fellow-worker, John Horne, followed him in May 1928. In response to a widely expressed desire that the eminent services rendered to geology by these two distinguished men of science should be recognised in some appropriate form, a representative committee was convened and has now decided to take steps to raise a joint memorial. The committee, which is under the chairmanship of Prof. R. A. Sampson, includes delegates from the Geological Survey of Great Britain, the Royal Scottish Museum, the geological departments of the Scottish universities, and the following scientific societies with which Drs. Peach and Horne were most closely associated: Royal Society of Edinburgh, Royal Scottish Geographical Society, Royal Physical Society of Edinburgh, and the Geological Societies of Edinburgh and of Glasgow. The committee proposes, with the concurrence of the authorities concerned, that the memorial shall take the form of a bronze plaque to be placed in a suitable position in the Royal Scottish Museum, Edinburgh, and of a commemorative inscription upon some conspicuous rock-face or boulder at one of the classical geological localities in the north-west Highlands. A fund has been opened to defray expenses, and the committee has appointed Mr. M. Macgregor, Southpark, 19 Grange Terrace, Edinburgh, to receive and acknowledge all contributions.

NEWS of another find of skeletal remains of early man in Africa is to hand. It is reported that during quarrying operations in Springbok flats in the northern Transvaal, fossil bones of man have been found in conjunction with the remains of an extinct gigantic buffalo. According to the Pretoria correspondent of the *Times*, in a dispatch which appeared in the issue of Feb. 9, the skull, long bones, and parts of the hands have now been found, but most of the vertebral column and the entire pelvis are missing. The skull and the other bones have been much broken, as if the hunter had been trampled by the buffalo. It is stated that the remains are those of a large-size man not closely related to the negroid type. The marked supra-orbital ridges of Rhodesian man are absent; but the lower jaw, though protuberant, has only a small chin, while the teeth are said to resemble those of Rhodesian man. This description would scarcely appear congruous with the attribution which is stated to have been put forward with confidence that the remains are of the Cro-Magnon type, and a possibility which is hinted that they may prove to be more primitive seems very likely.

DR. BROOM is reported in a later dispatch as regarding the Springbok man as proof of the existence of a primitive pre-negroid type in South Africa, and as establishing the hitherto doubtful standing of the Boskop skull. Whether this be the case or not, the find certainly seems likely to prove of very considerable importance. The absence of the supra-orbital ridges would clearly distinguish these remains from those of Rhodesian man, and they would thus add another to the early physical types which appear in the south of the continent. This range of type, of which unfortunately at present there is no evidence to fix the chronological sequence, would be in harmony with the archæological evidence which, according to the latest analysis, points to a succession of infiltrations into the sub-continent from the north.

ON p. 262 of this issue, we publish a summary account of Miss Garrod's recent presidential address to the Prehistoric Society of East Anglia, in which she gives a 'new view' of prehistory. It has for some time been evident that the results of archæological discovery outside the western European area could be brought within the classical order of de Mortillet only with increasing difficulty. This has perhaps been most impressed upon archæologists by the discoveries of Fathers P. P. Licent and Teilhard de Chardin in China. A full and exhaustive report on these discoveries has been issued by the Institut de Paléontologie humaine of Paris. M. Boule and the Messrs. Licent and Chardin themselves alike agree in regarding their discoveries as of vital import in the interpretation of the succession of palæolithic cultures in the West. Both geology and palæontology are now held to point to parity of conditions within a range extending from China to western Europe. Yet cultures which in the West appear in chronological succession, in the East appear to co-exist. Middle and Upper Palæolithic are combined. Hence such distinguished archæologists as M. Boule, the Abbé Breuil and Prof. Obermaier are coming to regard the succession of cultures in the West as a localised and peculiar condition due to a series of incursions from a centre of dispersion for which they look to Asia. It is interesting to note that the account by M. H. Martin of Solutrean frescoes found in a rock shelter in the valley of the River Roc (Charente) and the deductions he draws therefrom favour Miss Garrod's view as to the extent to which the Solutrean penetrated the

West. It is clear that Miss Garrod's plea for extended exploration in extra-European areas does no more than justice to the situation.

IN spite of a substantial reduction in its income, the Empire Cotton Growing Corporation is continuing its scientific research in the cotton plantations (see NATURE, Nov. 5, 1927, p. 645, and Mar. 10, 1928, p. 362). The quarterly report of the Executive Committee, which met on Jan. 23, makes this quite clear, as the following items show. The jassid-resisting strains of cotton evolved at the Barberton Experiment Station have reached the stage of rapid multiplication for distribution to the farmers, and are fully maintaining the high opinion formed of them. A number of them have been found to be early maturing —always a matter of first importance with regard to insect pests in warm climates. Similar work has now been undertaken in Southern Rhodesia, and there is already a promise that cotton growing will shortly enter into regular rotation with other crops. Considerable attention has been directed lately to the important research work being done in the Sudan. A committee was formed in this country to overhaul this work, and its decision was most favourable to its high scientific character.

SPECIAL studies are being made by the Empire Cotton Growing Corporation on the black arm disease of cotton, with the result that a very definite correlation has been observed between this fungus and soil temperatures. By regulating the time of planting to periods when the soil temperature is unfavourable to the development of the fungus, it is hoped that a considerable measure of control will result. A fresh appointment has been sanctioned to assist the pathologist in his work. Research in Nyasaland has sufficiently advanced to justify the opening of a station on the west side of the lake. Here the country appears to be specially suited for cotton growing, and will shortly be rendered accessible by the extension of the railway from Blantyre to the lake. Meanwhile, the research station in Trinidad is getting into its stride, and important papers have been and are being published in both the genetic and physiological sections. The papers issued have won warm eulogies from scientific men in Great Britain, in the United States, and on the continent of Europe.

IN the second lecture of his course on "The Early History of X-rays," delivered at the Royal Institution on Feb. 7, Sir William Bragg said that, like many other physicists of the same period, Röntgen was interested in the electric discharge in all the new forms which were being given to it by improvements in technique and especially by the increasing efficiency of the means for producing high vacua. Crookes, Hittorf, Lenard, and others had shown the marvellous properties of the so-called cathode rays. An additional factor in the discovery was the results of investigations with various phosphorescent substances. All the circumstances were therefore in favour of the discovery being made, and to Röntgen fell the honour of being the first to grasp the significance of an effect that others must have occasionally seen, and indeed did see about that time. His discharge tube was wrapped in black paper; yet one of these phosphorescent materials was set glowing when the discharge was made to pass. He also observed with curiosity that it made no difference whether the cardboard sheet on which his fluorescent material was spread was held with its back or front to the bulb. He assumed that a kind of ray, hitherto unknown, was emanating from the bulb. From that he went on to discover all the principal features of the rays and presented them in a paper of singular lucidity and order. All over the world delighted workers repeated his experiments. In Great Britain, J. J. Thomson, Campbell Swinton, Schuster, Porter, Jackson, and others helped in the rapid development of a new technique. The wonder of X-rays is now widespread, but the savour of the marvel of those first experiments will never be forgotten by those who had any part in them.

IN his Friday evening discourse, delivered at the Royal Institution on Feb. 8, Mr. C. E. R. Sherrington discussed "Recent Problems of Rail Transport at Home and Abroad." The retail and short distance nature of the rail traffic of Great Britain, he said, prevents the adoption of many methods used abroad, but the employment of labour-saving device—the corollary of high wage rates—is extending widely. Advocates of the Channel Tunnel scheme should not forget that the size of rolling stock in England is more limited in dimensions than that of Continental railways, while the practical difficulties experienced with steel sleepers abroad, such as the undesirability of using them with slag ballast, should limit their use at home to the time when they become a financially profitable improvement. The reinforced concrete sleeper is an alternative to steel, and can be more easily insulated where track circuits and automatic signals are required. The progress in signalling has resulted in the use of the day colour light signal, widely developed on the Southern Railway of Great Britain. Its universal adoption is to be expected in view of its penetrative power through fog, for automatic train control has not yet achieved that degree of infallibility which warrants the enormous cost of its application; this cost in the United States has often been more than £400 a mile. Freight service has been speeded up by the use of the rail-brake, now being installed for the first time in England at March, London and North Eastern Railway.

SINCE radio broadcasting was started five years ago its growth has been remarkable. Difficulties, however, are continually arising, which can only be overcome by persistent scientific research. In *Discovery* for February, Sir John Reith points out that the main difficulty arises from the fact that to-day there are nearly three hundred stations in Europe trying to broadcast on a wave band which is barely sufficient for a hundred. At the international conference at Geneva, Great Britain was allotted ten exclusive frequencies. Had it not been for the rapid growth in the number of stations, this arrangement might have sufficed. The actual result, however, is that the so-called exclusive frequencies are being encroached on

continually. Two years ago the nine main stations of the B.B.C. had an uninterrupted range of twenty miles for reception, and the relay stations had a range of five miles. Owing to interference, these ranges are now reduced to five and one and a half respectively. The radio engineers, therefore, are forced to erect a limited number of high power stations instead of the comparatively numerous low powered stations at present in use. The proposed new stations also will have two transmitters, each capable of operating on different frequencies, so that separate programmes can be transmitted simultaneously. The experimental results already obtained at the Daventry station (5GB) have proved eminently satisfactory. The first of the new high power regional transmitters is being built at Brookman's Park, near London. It will be in operation in the autumn of this year. Preliminary steps are being taken to erect high power stations to serve the north of England, Scotland, Wales, and the west of England. These will probably be completed in 1930. Until the regional scheme is ready, temporary measures are being taken to supply those listeners served by relay stations. It has to be remembered that the interference from distant stations increases after sunset, and so after dark the service of a station sharing a wave-length is decreased.

Dr. B. A. Keen, assistant director of the Rothamsted Experimental Station, has been giving talks through the British Broadcasting Corporation from September last on "The Why and Wherefore of Farming." The B.B.C. has now published, as part of this course, two pamphlets illustrating and amplifying the work. These pamphlets, giving a list of books to be read, and further work to be undertaken, should be in the hands of every agricultural student and teacher. They contain an admirable series of photographs, designed not merely to show the fundamental scientific character of farming but also to demonstrate the extent to which modern improvements have resulted in increased supplies of food and other commodities produced from the land. Especially instructive to the townsman are the illustrations of the improvements that have been effected in the types of plants grown. In the second pamphlet, to accompany the course this spring, are many excellent photographs of typical English farming scenes and operations, and few will wish for anything better in the way of illustration than these. Included at the end of each are instructions for the performance of simple experiments illustrating some of the more important subjects dealt with in the lectures. Appropriately enough, portraits of Jethro Tull and John Lawes form the respective frontispieces. From every point of view the object aimed at seems to have been achieved. The lectures have been illustrated in a most interesting way; further work on each has been suggested; the names of the books supplying the information have been supplied, and a scheme of simple practical work has been elaborated. The two slight pamphlets, because of the care expended upon their production, form a very interesting complement to Dr. Keen's lectures, and afford an illustration of the useful educational work which radio communication can accomplish.

The rapid growth of domestic electrical installations during recent months has greatly strained the resources of the meter departments of supply stations. In addition, there is no general agreement as to the type of tariff which is most equitable for the consumer and the supply company. The general principles laid down by John Hopkinson many years ago still hold good, and it is probable that the universal application of a two-part tariff to small users is only a question of time. The difficulty that has to be overcome in all the methods hitherto suggested lies in convincing the consumer that the method of charging is an equitable one. In a paper read by J. L. Carr to the Institution of Electrical Engineers on Feb. 1, an account was given of electric meters with special reference to those which are used to record in some particular way depending on the tariff system adopted. Practically all types of meters depend on their so-called permanent magnets remaining always the same. It is now well known that cobalt steel makes excellent permanent magnets. But some makers, probably on account of the cost, still use the older types of magnet, which from the point of view of remaining permanent leave much to be desired. Sooner or later every electric meter is called upon to withstand the effects of a temporary overload due to the development of some accidental fault on the circuit. Every time a fuse blows, for example, there is a heavy overload. It is well known that this may partially demagnetise the 'permanent magnets' and thus alter the rate at which the meter rotates for a given current. The present rapid extension of the use of domestic appliances connected to all parts of the house mains will doubtless increase the frequency of short circuits. Hence the effect of these on the rate of the meter is becoming important. The present standard specification, namely, that the rate should not be affected when a current thirty times the normal is passed through it for half a second, is not sufficiently stringent.

The present year being the jubilee year of Pope Pius XI., the Pontifical Academy of Sciences (Nuovi Lincei) has decided to offer a prize of 10,000 lire, to be awarded for the best critical dissertation on the physical theory of quanta. The prize is open to al except the ordinary members of the Academy, and dissertations, which must be unpublished, are to be submitted before Oct. 31 next. Three typewritten copies, in either Latin, Italian, French, English, German, or Spanish, must be supplied. Authors may give their own names or they may furnish a distinguishing motto, which must be repeated on a sealed envelope containing the name. The award will be made, on the recommendation of a special committee nominated by the committee of the Academy, at the inaugural meeting of the next academic year in December next.

Dr. F. C. Whitmore, head of the Department of Chemistry at Northwestern University, Evanston, Illinois, has been appointed Dean of the School of Chemistry and Physics at the Pennsylvania State College as from July 1 next. Dr. Whitmore succeeds Dean G. L. Wendt, who has been appointed assistant

to the president of the College in charge of research. Dr. Whitmore was director of the second session of the Institute of Chemistry, held at Northwestern University last summer, and during the year 1927–28 he was chairman of the Division of Chemistry and Chemical Technology of the National Research Council. He is the author of volume 3 in the monograph series published by the American Chemical Society, namely, "The Organic Compounds of Mercury," published in 1921, and was editor-in-chief of vol. 7, published in 1927, of the annual series entitled "Organic Syntheses."

The twenty-fourth annual report of Leicester Museum and Art Gallery refers to the good work done by the Director, Dr. E. E. Lowe, in his "Report on American Museum Work," and mentions that a new wing, to cost about £6800, will soon be available. This extension will be used for exhibition space, and will contain also a students' research room and a muniment room. During the year little change was made in the exhibited collections, some of which are still cramped for lack of space, but evening lectures, guide-demonstrations, and special Christmas lectures were much appreciated. More than a quarter of a million visitors entered the Museum, and the running of the Museum and Art Gallery cost £7182, £6873 of which was contributed by the rates.

A few years ago the Deeside Field Club, with its headquarters in Aberdeen, published as an experiment *The Deeside Field,* designed to interest the naturalist and the general reader in the many different aspects of Deeside life. The success of the experiment led to the appearance of three further parts, the last of which, recently published, contains a district miscellany of wide interest and high standard. Archæology is served by articles on pygmy flints, the first found in Scotland, a compendium of Deeside castles, and a discussion of Pictish symbols; natural history by accounts of the glacial geology of the Cairngorms, and of the rarer wild flowers of the valley; history by descriptions of Lumphanan and Durris; and there are many topical articles on old industries, the valley's painters, and so on. The Club is performing a useful service in encouraging research into these different sides of the development of the Dee valley and its people, and in giving the results permanent record. Its highly successful field excursions are no less useful in fostering acquaintance with a wide range of local interests, most of which have behind them more than local significance.

It is announced in *Science* that the Penrose medal of the Geological Society of America has been presented to Dr. J. J. Sederholm, director of the Geological Commission of Finland.

The Galton Anniversary Dinner of the Eugenics Society will be held at the Rembrandt Hotel, Brompton Road, on Saturday, Feb. 16, at 7.15 p.m. The Galton Lecture will be delivered by Major Leonard Darwin, who will take as his subject "The Coming of Age of the Eugenics Society."

As announced in our issue of Dec. 8, p. 898, the annual general meeting of the Chemical Society will be held at Leeds on Mar. 21. The presidential address, entitled "Co-operation in Science and Industry," will be delivered by Prof. J. F. Thorpe in the Great Hall of the University at 4.30 on that date.

An earthquake of moderate intensity was recorded at Kew Observatory at 17 hr. 23 min. 9 sec. G.M.T. on Feb. 1. The epicentre is estimated to have been in Afghanistan. A message from Bombay states that a shock was felt in Delhi. Another disturbance was recorded at 0 hr. 9 min. 59 sec. G.M.T. on Feb. 2. The epicentre was 4640 miles away, probably in Mongolia.

The following have been elected officers of the Royal Astronomical Society for the present year: *President:* Dr. A. C. D. Crommelin; *Vice-Presidents:* Sir Frank Dyson, Dr. E. B. Knobel, Prof. H. F. Newall, and Rev. T. E. R. Phillips; *Treasurer:* Mr. J. H. Reynolds; *Secretaries:* Prof. Herbert Dingle and Dr. H. Knox-Shaw; *Foreign Secretary:* Prof. H. H. Turner.

The Ministry of Health has issued a memorandum, arranged on the same plan as in former years, of the costs incurred at residential institutions for the treatment of tuberculosis (Memo. 122 B/T.). The information given should be of substantial assistance to authorities in enabling them to secure economical administration of their institutions.

We have received from the author, Mr. F. E. Corrie, a pamphlet on "Iodine for Livestock" (De Gruchy and Co., Ltd., 45 Mitchell Street, E.C.1). He has collected a large amount of information upon the value of iodine in the breeding and rearing of livestock, and describes methods whereby it may be fed to stock.

A brief account of outstanding features of the Indian Science Congress held in January 1928 at Calcutta appeared in our issue of Mar. 10, 1928, p. 401. The *Proceedings* of the Congress have now been issued as a paper-covered volume of 420 pages by the Asiatic Society of Bengal, 1 Park Street, Calcutta. The volume contains the addresses of the president, Dr. J. L. Simonsen, and the sectional presidents and abstracts of most of the papers presented. There is a subject and author index.

The Chemical Engineering Group of the Society of Chemical Industry has recently published vol. 9 (1927) of its *Proceedings*. It contains twelve papers dealing with various aspects of chemical engineering and covering a wide range. Three of the papers are concerned with lubrication and lubricating oils and another discusses the oil-pollution question at sea. Thermo-electric and resistance pyrometry in industry, the production of power from town's refuse, the importance of chemistry to the engineer, moulding machines for cast iron, fire extinguishers, the manufacture of fibrous cellulose, spray drying and the desiccation process of beet sugar manufacture, are considered in the remaining papers.

The usual bound volume, representing the Annual Report (for 1927) of the Smithsonian Institution, has recently been issued (Washington, D.C.: Government Printing Office, 1.75 dollars). In addition to the formal report of the expeditions and other activities of the Institution, there is the customary appendix, occupying fully three-quarters of the volume, which consists of brief accounts, by leading workers, of scientific discovery in particular directions. Many of the articles are original; one, by Sir James Jeans, is a reprint of the supplement to our issue of Dec. 4, 1926, entitled "Recent Developments of Cosmical Physics"; others, again, are translations. Such translations will be welcome to many scientific workers who are not at ease with a foreign language or do not see foreign periodicals regularly. The present volume includes "The Centenary of Augustin Fresnel," by E. M. Antoniadi (from *L'Astronomie*), "Is the Earth Growing Old?" by Prof. J. F. Pompeckj, and "The Origins of the Chinese Civilisations," by Henri Maspero (from *Annales de Géographie*).

Applications are invited for the following appointments, on or before the dates mentioned:—A head of the department of civil engineering, architecture, and building, and a lecturer in metallurgy, each at the Bradford Technical College—The Principal, Technical College, Bradford (Feb. 23). A junior scientific officer in the Admiralty Scientific Pool—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (Feb. 23). A secretary (male) of the City of London School—The Town Clerk, Guildhall, London, E.C.2 (Feb. 25). A full-time lecturer and demonstrator in anatomy at the University College of South Wales and Monmouthshire—The Registrar, University College, Cardiff (Feb. 28). A lecturer in mining engineering at Armstrong College—The Registrar, Armstrong College, Newcastle-upon-Tyne (Mar. 2). A Lady Carlisle research fellow for research in classics, mathematics, philosophy, history, economics, or natural science, and a research fellow in some branch of chemistry or biology, each at Somerville College, Oxford—The Secretary, Somerville College, Oxford (Mar. 6). A professor of mechanical engineering at the Heriot-Watt College, Edinburgh—The Principal, Heriot-Watt College, Edinburgh (Mar. 16). A chemist in the Main Drainage Department, Public Works Ministry, Egyptian Government—The Director General, Main Drainage Department, Public Works Ministry, Cairo, Egypt (April 30). A full-time teacher in electrical engineering at the Barnsley Mining and Technical College—The Principal, Harvey Institute, Barnsley. A junior assistant (male) under the Directorate of Ballistics Research, Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18.

Our Astronomical Column.

The Sunspot Cycle.—Mr. H. W. Newton gave a short address on this subject at the January meeting of the British Astronomical Association. The average daily number of spots reached a maximum in 1928, but as regards areas, the curve of activity has two peaks, one in 1926 and one in 1928, with a slight depression in 1927. The average latitude of spots, which was 14° in 1928, was considered as an indication that the maximum is now past. Ten spot groups were visible to the naked eye during 1928.

Mr. W. M. H. Greaves spoke on the correlation of spots and magnetic storms: the close resemblance between the spot curve and the curves of diurnal variations has long been known, but the research in which he has been engaged deals with the connexion between particular spot groups and magnetic storms. Spots on the limb appear to have little influence, but a large number of storms can be associated with particular spots near the central meridian, or with active regions where spots had recently been present.

Possible Return of Denning's Periodical Comet of 1894.—The new comet discovered by photography at Bergedorf on Jan. 17 last has been observed also at the Yerkes Observatory on Jan. 4 and 12, and a preliminary computation of the orbit leads to the inference that it may be a return of Denning's comet of 1894. The latter comet was observed for a short period only and its periodic time was deduced as 7·42 years. The small comet now visible gives undoubted evidence of being periodical and one of the Jovian group, with a time of revolution approximately 6·83 years or 6 years and 249 days. Quite possibly planetary perturbations may have altered the period in the interim of thirty-five years since 1894. In any case, the comet appears to have eluded rediscovery at four returns to perihelion, namely, in 1901, 1908, 1915, and 1922—but several of these occurred at very unfavourable times, when the comet was unsuitably placed.

It is now stated to be of the eleventh magnitude, and to be slowly declining in brightness, but it has not passed its perihelion. Only large telescopes can deal with it effectively, but photographic means will be employed to follow the object for some time yet.

Drawings of the Milky Way.—Two beautiful delineations of the Milky Way have just been published. Mr. Easton contributes to *Mon. Not. R.A.S.* for December two charts of the northern Milky Way which were photographically reduced from hand drawings; these in turn were made from a careful study of all the available photographs, the latest addition to these being the volume of Prof. Barnard's plates, edited by E. B. Frost and M. J. Calvert. The charts are reproduced in negative, and the contrast has purposely been somewhat exaggerated in order to facilitate detection of structure. A system of faint curved streamers extending to the Pleiades is of special interest.

The other work is a study of the southern Milky Way, by A. Pannekoek (*Annals of Lembang Observatory*, Java, Vol. 2, Part I.). His work was entirely visual, the brightness of different regions being compared by Argelander's step method. The reproduction is in negative, and is on a larger scale than Mr. Easton's; there are three charts, each covering 60° of galactic longitude, and key charts with reference numbers, which serve as a guide to the measures of brightness of the different regions that are given in the Introduction. The work also contains a few photometric measures of the Gegenschein and the greater Magellanic cloud.

Research Items.

PRE-PALÆOLITHIC IMPLEMENTS.—In vol. 5, pt. 3, of the *Proceedings of the Prehistoric Society of East Anglia*, Mr. J. Reid Moir has some further remarks on the archæological contents of the Forest Bed at Cromer. In 1926 and 1927 he again examined the remarkable spreads of flints exposed at low tide at Cromer, East and West Runton, and at Sheringham. It was noted that the flints differ in character at the different sites. On the Cromer site were found a number of black unchanged flints, obviously not due to human action; but among these are a number of flakes which do show a clearly defined bulb of percussion. These are due to the action of visitors and children searching for shell-fish, when either they are broken as slabs of rock are turned over or dropped to make them break. Although the fortuitously made bulb can generally be distinguished from the type of bulb shown by the ochreous specimen, there are some which are comparable. It is thought that these may be explained by an incomplete detachment in flaking which has afterwards jarred off. It is pointed out that no ochreous specimens occurred among the spreads of flint uncovered by the great storms of 1927–28 and bulbous flakes were conspicuous by their absence. It is also pointed out that some of the ochreous flints collected in 1927 bear evidence of glacial action in the form of striations on their flaked surfaces. It may not be out of place to direct attention in this connexion to some remarks by Mr. C. E. Vulliamy on the subject of tertiary man in *Man* for January. He points out that the rostro-carinate is one of the commonest forms produced by natural agency, and further, that while the flints attributed to human agency agree in size with the naturally shaped flints on their respective sites, prehistoric man must have gone to an immense trouble to produce an implement not too well adapted to his needs when there were innumerable natural forms ready to hand which would have served his purpose as well or better.

PREHISTORIC POTTERY AT MALTA.—The archæological section of the annual report of the working of the Museum Department, Malta, during 1927–28, contains several items of interest which are worthy of more than passing mention. Curiously enough, however, one of the most interesting observations arises out of the investigation of modern and not prehistoric material. In July 1927, during the levelling of ground outside the Porta Reale, Valletta, a number of potsherds were unearthed. These were fragments of household ware, mostly Sicilian, of the beginning of the seventeenth century. Among them were a number of fragments of large vessels, amphoræ jars, basins, bottles, etc., with thick walls and smooth outside surface. This ware was covered with a red slip on which elaborate designs in white line had been painted with a brush; but in some cases the slip was white and the lines red. This ware is North African rather than Sicilian, and was in common use in Tunis and Algeria in the seventeenth century. It is common on old sites in Malta and Gozo, in one case at least on a site corresponding to a Roman horizon. Dr. Gobert, who is studying this ware in Tunis, considers that it is a survival of a prehistoric industry. At Tarxien, which produced a number of smaller antiquities during the year, some interesting potsherds were found, of which one is of extreme importance. This is a fragment of a reddish-grey colour of a fine paste free from grit, the surface being smooth and hand polished. It is part of a plate exquisitely decorated with incised lines which are filled with red pigment. A border is composed of chevrons with a dot in the centre, and representations of trees and bulls are shown. Two profiles of bulls are preserved, one giving the horned head and shoulders, the other the body without the head. It is said to be the most beautiful piece of ware found at Tarxien, or indeed anywhere in Malta.

FREEMARTIN AND A FREEMARTIN-LIKE CONDITION IN SHEEP.—Mr. J. A. Fraser Roberts and Dr. A. W. Greenwood (*Jour. Anat.*, vol. 63, pt. 1, 1928) describe an undoubted bovine freemartin of extreme type in which the modification in the male direction was more pronounced than in any previously described case. The animal possessed a penis, traversed by a urethra which terminated in a vulva. There was no trace of a scrotum. In the second case the authors describe a freemartin-like condition in a sheep twin. This is specially interesting in view of the doubt which has been expressed as to the existence of the freemartin condition in sheep. The lamb described was a twin, but the sex of the other twin is unknown. The anatomy of the lamb was extremely similar to that of typical bovine freemartins, and the authors conclude that it was a freemartin of the bovine type. They suggest that a comparison of the bovine freemartin and developmental mammalian intersexes provides evidence for the view that the latter are genetic males and suggests possible criteria for a recognition of the genetic sex of mammalian intersexes. Even in the most extreme freemartin cases where the internal genitalia are almost completely male, there is no suggestion of the formation of scrotum or of prepuce where the penis of the male ends. This points to the fact that these structures do not develop in the genetic female. There is therefore good reason to suppose that a range of individuals that include cases showing these structures are genetic males.

GROWTH AND SEX IN THE LIMPET.—Dr. J. H. Orton (*Jour. Marine Biol. Assoc.*, November 1928) records observations which lead to the following conclusions: that *Patella vulgata* is not an ordinary diœcious species, that most, if not all, individuals are male at the first sexual maturity, that change of sex from male to female may occur at the age of one year and at any time afterwards, and that the occurrence of old males indicates the possibility of the existence of two kinds of males, one pure and one protandric. Spawning at Plymouth may extend from August to March in different seasons with a maximum about January to February. The conditions controlling breeding and spawning are unknown. Many limpets settled and grew on the cement piles of a new wharf constructed at Plymouth, hence the maximum age of these limpets was known. It was found that at an age of about one year, limpets grew to lengths of 26-35 mm. in 1912 and to at least 11-27 mm. in 1913; and at an age of two years to at least 53 mm. in 1911-13, and to 47-49 mm. in 1912-14. The shells were of the mid-tide-level type and were low, broad, and rather thin. It is considered that such growth in length is unusual and is correlated with the habitat and favourable climatic conditions. Seasonal shell growth is briefly discussed; a post-breeding shell-growing period is general in spring and early summer, but it is not known whether a mid-summer resting period is general among individuals more than one year old. Investigations into the cause of variation in shell-height indicate that height is determined probably entirely by the degree of exposure of limpets to desiccation—the drier the habitat the higher is the shell. Limpets submerged at neap tides have a relatively uniform low shell; those exposed at high-water neaps have a relatively high shell, which is

higher in the drier than in the damper situations, apparently irrespective of exposure to wave-action.

LOBSTER CULTURE.—*Naturen*, No. 10, for October 1928 contains an interesting popular survey by Mr. Alf. Dannevig of the history of lobster culture and of his experiments on rearing lobsters in Norway. His account of the experiments has already been noticed in our columns (Aug. 18, 1928, p. 253). In the present paper the growth of the lobster fisheries is traced from the beginning of the seventeenth century to our own times. Clear diagrams showing various statistics and figures of the larval stages as far as the fourth or 'lobsterling' stage are given, and photographs and figures of the experimental apparatus. In 1928 upwards of fifty thousand young were reared to the lobsterling stage, representing 34 per cent of the larvæ used for the experiments.

VITICULTURE: SCION AND STOCK INFLUENCE.—Whilst viticulturists will find much valuable information in the "Memorandum upon Viticultural Research," by D. Akenhead, published as E.M.B. 11, by the Empire Marketing Board, November 1928, horticultural investigators in general will find in it a very temperate analysis, with full citations of the literature, of the conflicting statements as to the influence of scion and stock upon one another in vine culture. The introduction of the *Phylloxera* to Europe, upon American vines imported because of their resistance to *Oidium*—when an insect that had seemed to be a relatively harmless leaf parasite developed as a scourge of the root system upon the old-established European varieties, at least in the southern part of their range—made the practice of grafting susceptible and valuable European varieties upon resistant American root stocks the immediate step to take to preserve the viticultural industry in southern Europe. Graft propagation then developed very rapidly, and upon a scale which rendered the provision of suitable root stock material a problem of great difficulty. The result has been an interminable controversy as to the effect of the introduced root stock upon the yield of well-known vine varieties, both in quantity and quality, and upon the length of life of the old-established varieties in the plantation. This report gives very concise data as to the conclusions reached by experienced nurserymen of the chief vine-growing countries in Europe, and by experimental stations both in the United States and Switzerland. The influence of scion upon root-stock is less evident to the practical man, though equally important in practice in the end, and has received less attention, but does receive consideration in observations upon strains relatively resistant to lime chlorosis.

THE INSECT-CATCHING MECHANISM OF THE BLADDERWORT.—Dr. Alexander Skutch has performed a valuable service for botanists in bringing together, in the *New Phytologist*, **27**, 261-297, December 1928, the literature dealing with this interesting problem. It will be news to most botanists that in four different countries, different observers, independently, within the space of fifteen years, recorded observations which give a direct clue to the method by which the insects are trapped. It now appears that the entrance of the insect is associated with a sudden change in volume of the bladder, which must be regarded as under tension, as a result of its method of growth, and the opening of the valve, itself still a matter of difficulty to understand, is accompanied by a rapid inrush of water which carries the insect with it. Some delay in observing the phenomenon is probably due to the fact that if the plant is taken out of water, most of the taut bladders 'spring' with an entry of air into the bladder. When this plant is observed afterwards, no further trapping of insects is likely to be seen upon it for some time. The conditions determining the entry of water into the closed bladder are an interesting subject of investigation. It appears that the closed bladder is sealed osmotically, the whole bladder being covered with a cuticle that behaves as a semi-permeable membrane. As a result it is very difficult to plasmolyse the cells of the bladder by immersing it whole in strong concentrations of inert substances, as the cells are able to withdraw more water from the liquid in the bladder. It also remains a problem to what extent the entrapped insects are killed and digested by the fluid of the bladder or the peculiar hairs lining the inner walls. Green organisms, such as *Euglena*, have been seen to live and multiply within the bladder; on the other hand, colourless organisms like *Paramœcium* seem to die more rapidly than under normal conditions.

GOLGI BODIES IN THE HIGHER FUNGI.—Prof. S. R. Bose, of Calcutta, writes to NATURE that, in view of Prof. Gatenby's letter in the issue of Dec. 3, 1927, he has re-examined the higher fungi, using Bowen's method. He then finds that Bowen's "osmiophilic platelets" are nothing but mitosomes, and (the bigger ones) the discoplasts of Dangeard. These are the mitochondria, greatly changed by swelling and vesiculation due to the action of the osmic acid in the fixative. As Guillermond has recently pointed out (*C. R. Soc. Biol.*, **98**, pp. 368–371, Feb. 1928), osmic acid, so satisfactory a fixative with animal cells, is very irregular in its action on the cells of higher plants. Prof. Bose finds that in the basidia of the higher fungi, no rod-shaped structures are seen, but only a number of round vesicular bodies. These are metachromatic corpuscles within the vacuoles of the basidia. They appear in almost the same position in the basidia on vital staining with neutral red. Prof. Bose directs attention to the fact that Dr. D. R. Bhattachargee, working on vertebrates at Allahabad, has concluded "that the Golgi bodies and vacuoles (vacuome) are homologous structures" (*Allahabad University Studies*, 1927–28). Dr. Viswa Nath, of the Punjab University, has also stated (in *Q.J.M.S.*, October 1928) that "the solid granular Golgi elements are artifacts produced by the excessive precipitation of metallic silver or osmium inside the vacuoles."

FLOODING OF THE DANUBE.—In a study of recorded Danube floods in an article in *Matériaux pour l'étude des calamités* for July–September 1928, L. Brandl shows that specially calamitous floods occurred four times during the nineteenth century, once in the eighteenth century, and at longer intervals in most previous centuries. Allowance must be made, however, for the incompleteness of earlier records and the liability of flooding to be less noteworthy when population was less dense along the river. The natural causes of the floods are shown to be twofold, the formation of ice-barriers and excessive rainfall. Ice-barriers were more frequent in past times before the river was regulated and its channels deepened. Then there is a record in the fourteenth century of an ice-barrier near Vienna which lasted seventeen weeks and caused the river level to rise six to eight metres. An ice-barrier below Bratislava in 1922–28 affected the level of the river many miles higher up. Protective and preventive works include the reinforcement of the river banks and the construction of dikes such as the one that protects Vienna.

INTRUSIONS OF SOUTH-EASTERN ICELAND.—In the *Quart. Jour. Geol. Soc.*, pp. 505-535; 1928, a detailed description is given of the main plutonic intrusions

of south-eastern Iceland by Miss H. K. Cargill, Dr. Leonard Hawkes, and Miss J. A. Ledeboer. The intrusions are found to be replacive stocks with steep sides and domed roofs, and no visible floor. Many are composite, being composed of gabbro with granite and/or granophyre; the biggest, however, Slaufrudal, is of granite rock alone. Where the outcrops are elongate in plan, the longitudinal direction coincides with the strike of the regional dykes. The suite of rocks is similar to that common elsewhere in the Brito-Icelandic or Thulean Province. Intermediate types are unimportant. The authors record a 'diorite,' but its description suggests that it is intermediate as a result of mixture of two magmas rather than as a consequence of differentiation. It is deduced from other evidence that two magmas, basic and acid, co-existed, but the extreme magmas are interpreted as products of differentiation which operated continuously throughout the history of the igneous cycle. No process which could produce such magmas is suggested. Intrusion of acid magma beneath Iceland is regarded as having saved Iceland from the general collapse of the North Atlantic plateau which occurred during the latter half of the Tertiary period.

INDIAN RAINFALL.—The Indian Meteorological Department has completed an important work on Indian rainfall. It is a summary of Indian rainfall for the fifty years 1875–1924, and constitutes the second part of the twenty-fifth volume of the *Memoirs* of that Department. The preface gives a brief history of rainfall measurement in India and explains how the present work, which was begun by Sir Gilbert Walker in 1913, was made possible by Sir John Eliot's introduction many years ago of a uniform system of measurement involving the use of gauges of standard pattern, tested before issue by the Department. The most important part of the undertaking was the construction of a table showing the rainfall for each of the many divisions and sub-divisions into which the country has been divided for climatological purposes, expressed as a percentage of 'normals' based on records obtained up to the end of 1910. As a method of arriving at an understanding of the causes of the variations, whether 'casual' or periodic, in the rainfall of India, an undertaking of this kind—involving the isolation of one meteorological element from the many others to which it is related—is of small value in proportion to the labour involved. It is rather in studies of the influence of that rainfall on the growth of crops and on public health, and as an aid in planning schemes of irrigation, that its real value must be sought; for these purposes the volume is well adapted, and inquirers should have no difficulty in obtaining in a minimum of time information that has been gained by the labours of many workers throughout two generations.

IONISATION BY COLLISION.—Many of the sources of uncertainty in quantitative measurements of ionisation by electronic impact are avoided by a device described by A. v. Hippel in a recent issue (No. 24) of the *Annalen der Physik*. Instead of passing into stationary gas, the electrons are shot at right angles through a beam of atomic particles which is issuing from a reservoir at the appropriate high temperature into a highly evacuated space. The products of ionisation pass on with the still unionised components of the beam, and are analysed in a receiving chamber by a mass-spectrograph, or by a simple electrical system. So far the method has been tried only with a beam of mercury atoms, and the results obtained are not in complete accord with those obtained by other methods which had previously been accepted as substantially accurate, but the use of atomic rays instead of gas or vapour should make it possible to study in a relatively straightforward way a considerable number of refractory substances which would otherwise be very difficult to investigate.

COUNTING SCINTILLATIONS.—During the course of an investigation of the various factors involved in the counting of α-particles by the method of scintillations, which is described in the January issue of the *Proceedings of the Royal Society*, J. Chariton and C. A. Lea have obtained some results of great interest in connexion with the mechanism of the human retina. Considered as a detecting instrument, it has long been recognised that the eye is extremely sensitive, but the figures now given are very striking. It appears that, in the most favourable circumstances, a skilled observer requires only some twelve quanta of green light, with a total energy of about 5×10^{-11} erg, to excite the sensation of vision. The optimum conditions for reception occur when the flashes follow one another regularly, and so can be directed to that part of the retina which is most sensitive; the passage of the nerve impulses to the brain should also have been facilitated by previous abstention from food, or treatment with a tonic drug such as strychnine, whilst the area stimulated should be small, possibly not more than a single retinal element. The duration of the flash is immaterial, so long as it is spread over a period of less than about a hundredth of a second. Another important point discussed is that of the nature of the feeble scintillations sometimes produced by β-rays; it has been shown that each flash corresponds to the simultaneous incidence of several β-particles on one of the small phosphorescent crystals, in sharp contrast to the scintillations due to α-rays, where in the majority of cases of practical interest each flash registers the impact of a single α-particle.

A NEW COLORIMETER.—Part 5 of volume 29 of the *Transactions of the Optical Society* contains a description of the new colorimeter devised by Mr. W. D. Wright in order to carry out some researches on colour vision for the Medical Research Council, and in particular to determine for a large number of observers the locus of the spectral colours in the colour triangle. The new instrument utilises three of the spectral colours as the three primaries of the triangle. They are combined by reflecting prisms placed in the spectrum, which return the three colours along their paths of incidence to a reflecting prism which deflects them out of that path to the photometer, where they fill half the field. The other half is occupied by the colour to be matched, which is also obtained from the spectrum. Variations of intensity of the light of any colour is produced by the introduction of a neutral tinted gelatine wedge which may, if found too variable, be replaced by a black glass wedge. The instrument in its present form occupies a considerable space, but it could be simplified and reduced in size if required for industrial purposes.

VITAMIN B.—It has been suggested by Jansen and Donath that vitamin B is a glyoxaline derivative, and Y. Sahashi has commenced the preparation of a series of glyoxaline derivatives in order to study their effect upon the polyneuritis of pigeons. The first compound to be prepared was 4 (or 5) glyoxaline-ethyl-methyl-carbinol, which brings about a temporary cure of polyneuritis and in this respect resembles 2-6-dioxy-quinoline. After 7-10 days, however, the pigeons invariably died. This work is described in the December issue of the *Abstracts* of *The Bulletin of the Institute of Physical and Chemical Research, Tokyo.*

Remarkable Clouds at High Altitudes.

By Prof. CARL STØRMER.

BETWEEN 1871 and 1892 some very remarkable clouds were seen both in England[1] and in Norway. These clouds, which before dawn or after sunset were characterised by their brilliant prismatic colours, were especially studied by the late Prof. H. Mohn.[2] Visual observations in England in 1885, and by Prof. Mohn in 1892, made it very probable that their altitude was exceptionally great, but no certain conclusion could be drawn from these visual observations.

I saw these clouds in the year 1890 and made very careful observations of their forms and colours, but after 1892 I did not see them at all in spite of a very careful watch. It was not until Dec. 27, 1926, that I saw them again. That afternoon I was unable to determine their height, but some days later, on Dec. 30, I succeeded in taking two pairs of simultaneous photographs of them from my two aurora stations, Bygdö and Oscarsborg. The measurement and calculation of these photographs gave heights between 26 km. and 30 km. above the earth.[3]

FIG. 1.—Nacreous clouds to the west, seen from Oslo.

On Jan. 13 of this year the clouds were again seen, both in the early morning and in the evening. I was fortunate enough to have my two stations, Oslo and Oscarsborg, in action immediately after sunset, and a long series of more than ninety simultaneous photographs were taken from both stations. These give unique material for determining the exact height and situation of these remarkable clouds.

I myself conducted the photographic work from the astronomical observatory, and simultaneous photographs were taken in Oscarsborg by my assistant Hafnor by orders over the telephone. My assistant in Oslo was Tveter.

The best photographs were taken so late that the stars were visible, which allowed us to measure and calculate the height and situation of the clouds in the same manner as I have done in the case of the aurora borealis.[4] In fact, the clouds remained luminous until three hours after sunset.

FIG. 2.—Photograph taken from Oslo.

[1] See NATURE, vol. 33, pp. 220 and 486.

[2] "Perlemorskyer," *Christiania Videnskabsselskabs Forhandlinger* for 1893, and "Irisierende Wolken," *Meteorologische Zeitschrift*, March 1893.

[3] "Photogrammetrische Bestimmung der Hohe von irisierende Wolken (Perlmutterwolken) am 30. Dec. 1926." *Geofysiske Publikasjoner*, vol. 5, No. 3. Oslo, 1926.

[4] *Geofysiske Publikationer*, vol. 1, No. 5. Oslo.

FIG. 3.—Photograph taken simultaneously with the preceding one (Fig. 2), from Oscarsborg.

Thus we have the same order of altitude as the clouds photographed on Dec. 30, 1926.

As Prof. Mohn had already found, these remarkable clouds are associated with an atmospheric depression to the north of Oslo, giving typical Föhn from the mountains in the west and north with high temperature and clear weather. In this way it has been possible to have a view upwards through a cyclone in that part which is generally obscured by clouds and rain. It may be possible that the iridescent or nacreous clouds are much more common over the ascending part of a cyclone, but that they are in general invisible, except in the case where a Fohn makes that part transparent so that the nacreous clouds can be seen.

The preparation of the whole material obtained may give a good deal more information about these remarkable clouds.

Fig. 1 is from a photograph taken from Oslo just after sunset, through a red filter on panchromatic plates. The most luminous parts shone in beautiful colours like mother-of-pearl.

One of the best pairs of simultaneous photographs was taken at 16 h. 40 m. 30 s. G.M.T. to the west. Fig. 2 and Fig. 3 are reproductions of the photographs taken from Oslo and Oscarsborg. The colours had then disappeared, but the clouds were still visible among the stars. In the photographs the star Atair is seen near the centre, ζ Aquilæ to the right, and the constellation Delphinus up to the left.

Along the outlines of the clouds we have chosen fourteen points, the positions of which are seen on the diagram Fig. 4.

As the distance separating the aurora stations is about 27 km., the parallax was great, which gave a very trustworthy determination of height.

The result was as follows :

Point.	Height.	Point.	Height.
1	25·3 km.	8	24·3 km.
2	25·6 ,,	9	23·4 ,,
3	26·1 ,,	10	24·5 ,,
4	25·1 ,,	11	23·1 ,,
5	24·8 ,,	12	23·0 ,,
6	22·4 ,,	13	23·9 ,,
7	24·3 ,,	14	22·3 ,,

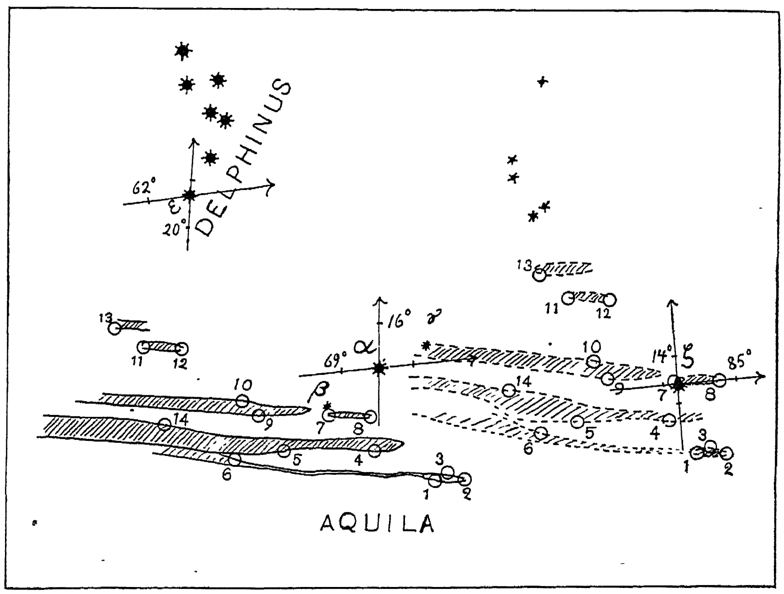

FIG. 4.—The clouds as seen from Oslo are shown by complete lines and as seen from Oscarsborg by dotted lines; corresponding points have the same number. For each star two directions are marked : The vertical circle and the great circle through the star and the point K where the direction Oslo to Oscarsborg meets the sky (direction of parallax). On these directions are marked the height above the horizon and the angle between the direction of the star and of the point K.

New and Old Views in Prehistory.[1]

IN her presidential address, recently delivered to the Prehistoric Society of East Anglia, Miss D. A. E. Garrod reviewed the present position of research in prehistory.

Now that research is spreading far beyond the confines of western Europe, it is clear that the classic sequence of culture periods, from the Chellean to the Magdalenian, cannot be applied to all regions in its entirety. Mortillet's classification represented the sequence in time of a certain number of palæolithic cultures, seen, as it were, in section over a very limited area of the earth's surface, but that classification records only the order of arrival in the west of a series of cultures, each of which has originated, and probably passed through, the greater part of its existence elsewhere. The time to find a new classification appears to have come.

An attempt is made to restate the evidence in a chart (Fig. 1) showing the relations of the palæolithic cultures of Europe. The Upper Palæolithic is divided into two branches—the Capsian and the Aurignacian—here regarded as separate offshoots from a common stock at present unknown. This view is at variance with that hitherto accepted; but it is suspected that the centre of dispersal of the Upper Palæolithic cultures may have been in Asia rather than in Africa. Evidence from the Caucasus, from Syria and from Palestine, points to an Aurignacio-Mousterian industry, though its association with the Galilee skull classifies the culture of the Zuttiyeh Cave as Mousterian despite its mixed character. The contact of Mousterian and Aurignacian in Palestine is, evidently from the characteristics of both, earlier than that of Abri-Audi. It is tentatively suggested that in Palestine the centre of dispersal is not far off and that the evidence is slightly in favour of the French Aurignacian being derived from the East rather than North Africa. As regards the Solutrean of the West, the evidence points to it being merely an influence from the Solutrean people of the Hungarian plains, at present of unknown origin.

While one branch of the Aurignacian or European Upper Palæolithic stem fused with the Solutrean from Central Europe, the other branch developed into the Magdalenian, the one truly indigenous palæolithic culture of the West, which later became the prevailing culture in France and the Cantabric region, and spread in an impoverished form into Central Europe and into Belgium and England.

The pre-Capsian industry of the Manzanares Gravels, and of the Low Terrace of Moutiers of the Somme Valley—"Warm Mousterian"—show that the precursor of the Upper Palæolithic had already come into being while the Acheulean was still the dominant industry of the West. The Mousterian, Breuil holds, is the result of a fusion of three elements, the Acheulean, the Levallois flake, and the pre-Mousterian flake industry of Central Europe of the Riss-Würm interglacial deposits at Ehringsdorf, Taubach, and Krapina. As Chellean and Acheulean are not found in Central Europe, this pre-Mousterian must take their place and go back to the first interglacial. Presumably the Heidelberg jaw belongs to an early phase of this. It is possible that the culture of High Lodge, Mildenhall, which presumably belongs to a Riss-Würm interglacial, the estuarine culture of Clacton and the Swanscombe deposits may be derived from the Central European culture. According to Breuil, the second element of the Mousterian proper, the Levallois flake, persisted throughout the Riss-Würm inter-glaciation until it coalesced with the

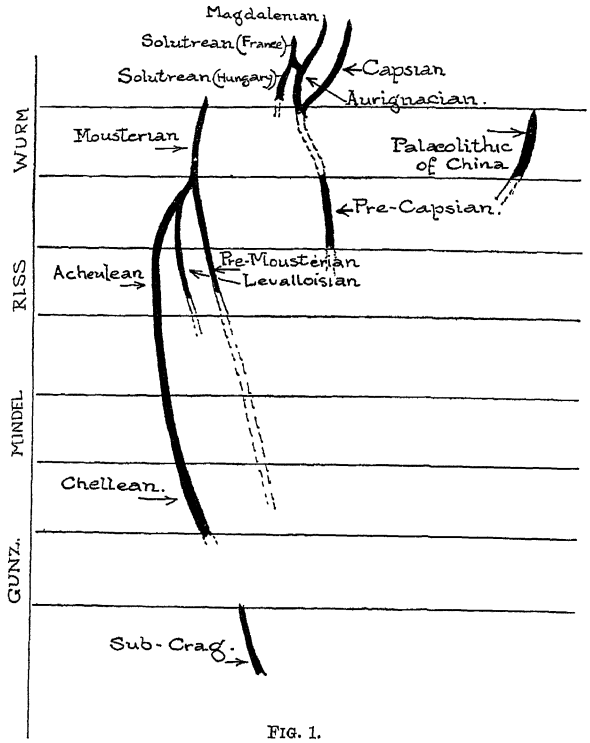

FIG. 1.

Acheulean in the Combe Capelle industry at the beginning of the last glaciation. It is impossible at present to trace further back these contributory industries, except the Acheulean; but there can be no doubt that it develops without a break from the Chellean, at present of unsolved origin.

The recently discovered palæolithic culture of China, combining the characters of the Upper and Middle Palæolithic, but not typical of either, may be explained if, the centre of dispersion being Central Asia, it is regarded as related to the West by descent from a common stock.

The chart is purely tentative and intended to stimulate investigation in those great regions where prehistory is as yet unknown.

[1] To be published in full in *Proc. Prehist. Soc. East Anglia*, vol. 5, pt. 3.

Mechanism of Twinning in Metals.

ARTIFICIAL or mechanical twinning may be regarded as the result of a movement within a crystal by which the orientation of the atoms, in a band bounded by parallel planes, becomes a mirror image, with respect to these planes, of the orientation of the atoms in the unchanged matrix on either side. If such a twin band is to result from a mechanical impulse, for example, from an impulsive shear tending to depress the matrix on one side of the band with respect to that on the other, this relative movement of the material on either side of the planes bounding the twin band must be accompanied by a uniformly graduated or 'wheeling' movement of the atoms within the bounding planes.

The problem is to examine, for a given lattice, the different ways in which a movement of this kind may occur, and to decide which of them is likely to be produced most easily. The mechanism of twinning in the body-centred cubic lattice forms the subject of Part I. of a paper recently published ("The Mode of Formation of Neumann Bands," by S. W. J. Smith, A. A. Lee, and J. Young, *Proc. Roy. Soc.*, A, vol. 121, No. A788, Dec. 3). If a 'wheeling' movement of the atoms within the bounding planes is to take place in such a way that the twin relationship between the band and the matrix is to be produced, the line in which the plane containing the 'wheeling' atoms meets the twinning plane must be an axis of symmetry for the atomic distribution in the plane. The angular 'wheeling' movement during twinning is determined by the angle between the twin plane and the atom or 'wheeling' plane. The larger the acute angle between the possible twin plane and the possible atom plane the smaller is the angular movement required to produce the twin orientation of the band with respect to the matrix.

Examination of the conditions of twinning in the body-centred cubic lattice shows that the form of twinning most likely to occur is that of the type in which the twinning plane is $\bar{1}12$ and the atom plane is $1\bar{1}2$. By symmetry, the same type of twinning will occur with $1\bar{1}2$ as twin plane and $\bar{1}12$ as atom plane. During the transition from the initial configuration to the twin configuration the movement of the atoms produces a temporary increase in the 'width' of the band of the matrix in which the twinning occurs. Half-way through the twinning movement the 'openness' of the structure is at its maximum, and the atoms lie midway between two forms of the body-centred configuration. In this position the slightest bias, forward or backward, will tend to make the system move, under the operation of interatomic forces alone, forward towards the twin lattice or backwards towards the original one.

The markings produced in iron by shock were discovered by Neumann in 1850, and since then a number of investigators have studied the nature and mode of formation of these bands. In Part II. of their paper referred to above, S. W. J. Smith, A. A. Lee, and J. Young furnish indisputable evidence that the bands are twins. By X-ray analysis it was found that the hexahedral meteorite (Coahuila) with which most of the experiments were made, has a body-centred lattice, similar to that of the constituent—kamacite—to which the Neumann bands in octahedral meteorites are confined. The orientation of the cubic lattice of a meteorite having been determined, the geometrical relationship between the bands and the matrix was found by measuring the direction of the bands on polished and etched sections parallel to various faces. In the meteorites examined the Neumann bands were found to lie on {112} planes.

Direct evidence that the material within the bands is in twin orientation with respect to the matrix was obtained by examination of the figures produced by etching with copper ammonium chloride. This etchant in dilute solution produced very beautiful flat-bottomed etching figures (negative crystals), bounded by rhombic-dodecahedral planes, whereas dilute nitric acid produced long ridges and troughs with {100} planes on their sides. The simplest way of deciding whether the twin relationship exists between the orientation of a band and that in the adjacent matrix is to make a section of the material perpendicular to the {112} plane, to which the band is parallel, and to compare the pits produced simultaneously on band and matrix. In such a case the twin relationship is demonstrated by the fact that the etch-pits in the band are mirror images of those in the matrix.

Some difficulty was experienced in photographing the pits because of the different focus required to show the symmetrical contour and the facets, but, despite this difficulty, some very conclusive photographs at high magnification ($\times$ 1680) were obtained by selecting an intermediate focus. Etch-pits in a number of bands and in the adjacent matrix were examined and photographed, and by this means the twin relationship was established. The movement involved in the formation of Neumann bands was determined from the displacement produced when the track of one band was crossed by another formed at a later time.

University and Educational Intelligence.

CAMBRIDGE.—The prize of £30 from the Gordon Wigan income for physics and chemistry for a research in chemistry has been awarded to J. G. A. Griffiths, of Emmanuel College, for an investigation on the photochemical decomposition of glyoxal.

Two noteworthy contributions to the subject of medical education have recently been published. One was the eleventh series of "Methods and Problems of Medical Education," issued by the Rockefeller Foundation, N.Y., dealing for the most part with special departments (eye, nose, children, etc.) of hospitals and universities in the United States and Europe, their construction and organisation. The second was a special Supplement to the *Lancet* (Jan. 5), containing a review on medical education in the United States and Canada by the editor, Sir Squire Sprigge. He makes no attempt to formulate conclusions, but directs attention to two fundamental divergencies worthy of further inquiry. In Great Britain the tendency is to divorce the hospital from the university and to regard the former only as an adjunct to university education, but in America and Canada the medical school is an integral part of the university, which controls the teaching given in the hospital.

IN the Departments of Textile Industries and Colour Chemistry and Dyeing of the University of Leeds, the progress of research work has been stimulated by a recent grant of £3000 a year for four years by the Clothworkers' Company of the City of London, enabling the University to institute a lectureship in textile physics and two assistantships and eight fellowships and scholarships for graduate students. With the same object in view the University has conceded to selected research workers attached to the laboratories at Torridon of the British Research Association for the Woollen and Worsted Industries, the privilege of reading for higher degrees at the University. These developments have quickly borne fruit: the number of graduate workers in the Department of Textile Industries being nearly three times what it was last session. There are also 80 per cent more full-time students and 13 degree students as against 5. Several lines of research in this Department are, says the Report for 1927–28, converging to give an interpretation of the molecular structure of wool. These are: physico-chemical research on the gel structure of the wool fibre, a survey of the elastic properties of a number of wools at various humidities and temperatures up to 100° C., and investigations of the plasticity of wool, and the dependence of rigidity on relative humidity.

Calendar of Patent Records.

February 16, 1807.—A patent was granted to Charles, third Earl Stanhope, on Feb. 16, 1807, for a construction of ship that would withstand submarine bombs and similar attacks. Lord Stanhope was the friend of Robert Fulton, and was partly responsible for Fulton being called to England from France during the Napoleonic wars to demonstrate the possibilities of his submarine boat for war purposes.

February 16, 1904.—The 'stepney wheel,' the first successful solution to the puncture problem of the modern motor-car, was invented by Thomas and Walter Davies, and patented by them on Feb. 16, 1904. The name of the wheel was derived from the address of the inventors, Stepney Street, Llanelly.

February 20, 1806.—The first canal lift as a substitute for the ordinary lock was erected at Tardebigge, near Bromsgrove, on the Worcester and Birmingham Canal. It was the invention of John Woodhouse and was patented by him on Feb. 20, 1806. The lift consisted of a wooden tank 72 ft. long, 8 ft. wide, and 4½ ft. deep, which was hung on a series of chains passing over cast-iron wheels 13 ft. in diameter. The tank weighed 64 tons when filled with water and was counterbalanced by masses of brickwork on timber platforms hanging from the other ends of the chains. It is said that the lift could be raised or lowered by two men in three minutes. The arrangement soon, however, fell into disuse and has since been replaced by a long flight of locks. A few other such lifts were erected, but did not survive long, and the lift system did not become successful until hydraulic operation was introduced about 1870.

February 22, 1904.—The 'thermos flask' was introduced under the English patent of Reinhold Burger of Berlin, which was dated Feb. 22, 1904. The invention consisted simply in the commercial adaptation of the heat-insulated vessel employed for the first time some ten years earlier by Sir James Dewar in his scientific work on the liquefaction of gases, and the validity of the patent was challenged successfully in the Courts. No German patent was granted, but a *gebrauchsmuster* for the design had been obtained in 1902.

February 24, 1839.—The first patent to mention sulphur in connexion with the treatment of india-rubber was that granted in the United States to Nathaniel Hayward for the "combining of sulphur with gum elastic either in solution or in substance," on Feb. 24, 1839. The patent was applied for at the instigation of, and was afterwards assigned to, Charles Goodyear, who later on in the same year discovered the process of vulcanisation, though he did not obtain his patent for the invention until 1844, a few months after Thomas Hancock, who had been working in the same field, obtained an English patent.

February 24, 1881.—Among the early systems of electric traction for street railways was that known as the surface-contact system, in which studs arranged at intervals along the track were normally disconnected from the electric supply mains and were only brought into the circuit when in actual contact with the current collector on a tramcar. The first patent for this system was granted to Profs. Ayrton and Perry on Feb. 24, 1881, two months before the first commercial electric tramway (using both running rails as conductors) was opened near Berlin. The surface-contact system has been tried in various towns in Great Britain, but was never entirely satisfactory and has been superseded by the overhead system.

Societies and Academies.

London.

Mineralogical Society, Jan. 15.—A. Holmes and H. F. Harwood: The tholeiite dikes of the north of England. These dikes, bounded on the north by the Acklington dike and on the south by the Cleveland dike, form an outlying part of the Mull swarm. To the Salen, Brunton, and Talaidh types, already recognised in Mull, the authors add Cleveland and Acklington types, and anorthite-bearing varieties of each. Chemical and mineral analyses are presented, and from a comparative study of the evidence it is shown that there are many features in the series as a whole which are not in accordance with the theory of crystallisation-differentiation.—A. Russell: On the occurrence of gold at Hope's Nose, Torquay, Devonshire. A detailed description of a remarkable occurrence of crystallised arborescent gold in calcite, in Middle Devonian limestone at Hope's Nose, where it was discovered by Prof. W. T. Gordon in 1922. Specimens have since been obtained from five distinct veins. The gold varies in colour from a bright rich gold to almost silver-white, and has a silver content of only 1·89-8·41 per cent.—H. E. Buckley: Crystallography of some organic compounds. Collected records of goniometric measurements on crystals of various organic compounds.

Linnean Society, Jan. 17.—G. Enderlein: The Copeognatha of the Seychelles. Particular attention was devoted to the booklice and allied insects in 1908, and forty-seven species, belonging to twenty-seven genera, were collected. Six families are represented, and the scaly-winged forms (Lepidopsocidæ) account for more than half the species. The abundance of Copeognatha was a feature of insect life in the Seychelles. They were collected mainly by sweeping and beating foliage in the native forests at 1000-2000 feet above sea-level, but some were taken also among non-endemic vegetation at lower levels. Ethiopian elements seem to predominate, although many groups of Seychelles insects are largely Eastern in origin.—S. Maulik: Chrysomelid Coleoptera of the subfamilies Eumolpinæ, Galerucinæ, and Halticinæ from the Seychelles and other islands of the western Indian Ocean. There are sixteen species, fifteen being described as new, distributed among nine genera, four of which are new to science. Twelve species were found only in the Seychelles, one in both the Seychelles and Aldabra, two in Aldabra only, and one in the Farquhar Group. The material, as a whole, indicates an endemic element in the Seychelles fauna, with some Austro-Malayan affinities, also certain forms which have probably been imported; while the relationships of the Aldabran species are with Madagascar and Africa.—A. B. Rendle: A remarkable West Australian subterranean orchid recently described by Dr. R. S. Rogers. The plant consists of an underground rootless rhizome in symbiotic relationship with a fungus which closely invests the decayed roots of *Melaleuca uncinata* R. Br. It lives about a foot below the surface of the ground. The flowers are borne in a dense head surrounded by an involucre of bracts which grows apparently towards the surface. The inflorescence, which suggests the capitulum of a Composite, reaches about three inches across. It is placed by Dr. Rogers in a new sub-tribe, to come next to Gastrodiinæ.—F. E. Lloyd: The resistance of the door of the *Utricularia* trap to water-pressure. The trap is not only self-setting, but also, if uninjured, remains permanently in the set condition, as the result of negative pressure of

water within it. The maintenance of the negative pressure depends upon the efficiency of the door. The upper surface of the threshold of the door has a peculiar epithelium of soft thick-walled compact cells forming a smooth mosaic. Across this the lower door-edge glides outwardly in resuming its normal position after the trap is sprung. But the outer two cell-rows of this tissue grow out to form a membrane providing a sort of pocket in which the middle portion of the door-edge rests, effectively closing the rift between the door-edge and the edge of the threshold against which it rests.

Optical Society, Jan. 17.—**E. F. Fincham**: The function of the lens capsule in the accommodation of the eye. The form of the anterior surface of the lenses of freshly dead animals is determined by making photographic records of the image reflected from the surface. The results show that in primates the anterior surface of the lens assumes a somewhat conical form with an area of increased curvature in the centre, when the suspensions are severed. The capsule of the primate lens has a zone of increased thickness surrounding a central thin area. The anterior lens capsule of animals of an order lower than the primates is approximately uniform in thickness, and the removal of the capsule does not cause an appreciable change in the form of the lens. The theory is formulated that accommodation consists of a relaxation of tension upon the lens by the contraction of the ciliary muscle as stated by Helmholtz. This relaxation allows the capsule to press upon the lens substance and mould it into the accommodated form. The unaccommodated lens substance is therefore in its unrestricted or natural form and not under compression as supposed in the Helmholtz theory.—**D. S. Perfect**: A double reflection level. The level was designed to assist the initial levelling of a floating system and to enable observations to be made on the constancy of level over extended periods of time. Its error may be determined by direct measurement and without reversal.—**T. Smith, J. S. Anderson**, and **L. C. Cordle**: Photographs of reflection caustics. Caustics formed by reflection at the surfaces of a photographic lens are described.

EDINBURGH.

Royal Society, Jan. 21.—**R. B. Mooney** and **E. B. Ludlam**: The thermal equilibrium between ethylene, iodine, and ethylene di-iodide. The pressure of ethylene in equilibrium with a mixture of solid iodine and solid ethylene di-iodide was measured by means of a glass-spring manometer. Observations were made at temperatures between 10° C. and 65° C. The vapour pressure of undissociated ethylene di-iodide was determined at four temperatures within the same range by the gas stream method.—**E. B. Ludlam, H. G. Reid**, and **W. B. Soutar**: The flame of chlorine burning in hydrogen. The flame consists of a livid white inner cone ascribed to the re-combination of dissociated chlorine atoms, and an outer blue zone which gives a band spectrum in the violet and near ultra-violet. This spectrum is provisionally regarded as due to the hydrogen chloride molecule (see NATURE, Jan. 19, p. 86).—**R. W. Armour** and **E. B. Ludlam**: The photochemical equilibrium between hydrogen, bromine, and hydrogen bromide. Light of very short wave-length (185 $\mu\mu$) should have a slight effect in causing the formation of hydrogen bromide from its elements. Using the aluminium spark as a source of light, at equilibrium the partial pressure of the hydrogen bromide is slightly less than 2 per cent that of the bromine. The absorption coefficient of bromine has also been measured in the ultra-violet region 254 $\mu\mu$-185 $\mu\mu$ by means of a photo-electric cell; bromine is less opaque in this region than was previously supposed.—**W. W. Taylor**: (1) The lyotrope effect and the antagonistic action of ions. The lyotrope effect is well shown in the precipitation of ferric hydroxide sol by neutral salts, although the concentrations are very small. No antagonistic action is shown by Li and Mg, or by K and Ca; the effect is *additive*. ClO_3' and SO_4'' show the opposite effect of *adjuvant* action which amounts to 50 per cent. The opalescence-temperature of a phenol-water system is affected lyotropically by equivalent solutions of salts (both for cations and anions). The lyotrope effect seems to be an expression of the water-binding power of the salt.—(2) Demonstration of a new method of determining 'free' and 'bound' water. The method follows from the above experiments on the effect of solutions on the opalescence-temperatures of a phenol-water system. Opalescence-temperatures are determined, and from these data the ratio of 'free' to 'bound' water can be ascertained, the assumption being made that the 'free' water of the solution is alone effective in this respect.—**W. O. Kermack, A. G. McKendrick**, and **E. Ponder**: The stability of suspensions. (3) The velocities of sedimentation and of cataphoresis of suspensions in a viscous fluid. A theoretical investigation confirmed by experiments on the sedimentation of red blood cells in the Goughian or spherical form. In both sedimentation and cataphoresis the velocity of any particular particle is retarded as the result of the presence of the other particles, so that the velocity of a particle in a suspension is less than that of an isolated particle. When a cloud of particles is subjected to cataphoresis, the rear boundary tends to be sharply defined and the front to become more and more diffuse. The reason for this is that if an isolated particle happens by chance to lag behind the general swarm, its speed is accelerated, and so it tends to make up on the others, whereas if it happens to take up a position in advance of the general swarm, the acceleration which it experiences carries it still farther ahead.

PARIS.

Academy of Sciences, Jan. 14.—**L. Lecornu**: The Clapeyron cycle.—**Maurice Fréchet**: Probable convergence.—**Mme. M. Piazzolla-Beloch**: Surfaces of the third order possessing curves with linked branches.—**S. Rossinski**: A class of couples of stratifiable rectilinear congruences.—**Radu Badesco**: A generalised Abel integral equation.—**Srivastava**: The singularities of a class of series of Dirichlet.—**B. Gagaeff**: The unicity of a system of orthogonal functions invariant relatively to the differentiation.—**Alex. Froda**: The maxima and minima of uniform functions of real variables.—**Z. Horak**: The principles of a general theory of shock.—**J. Le Roux**: A general property of the movement of a system of material points.—**J. Kampé de Fériet**: The connexion between the absence of negative pressures and the sense of the concavity of the stream lines in the plane movement of an incompressible fluid round an obstacle.—**E. Baticle**: The curving of grooved elliptical arches.—**Mesnager**: Remarks on the note of M. Baticle.—**H. Mineur**: The rotation of the galaxy. A different result from those of Oort and of Plaskett is obtained, and the cause of this is discussed.—**Mario Bossolasco**: The ellipticity of the terrestrial equator.—**A. Guillet**: The photographic registration of an angular velocity. Application to ballistic measurements.—**L. Brillouin**: The electronic theory of metals, according to Sommerfeld, and the mean free path of the electrons.—**M. Ponte**: The diffraction of the electrons by crystalline powders. Electronic analysis.—**Marcel Cau**: The

double refraction and dichroism of thin layers of iron obtained by distillation.—**Jean Cabannes**: The secondary radiations in the light diffused by quartz. —**Maurice Lambrey**: The ultra-violet absorption spectrum of nitrogen peroxide.—**Nathaniel Thon**: The electromotive potential and electrokinetic potential of graphite.—**M. and Mme. Lemarchand**: The application of the law of mass action to double decompositions of salts.—**H. Swietoslawski**: A new application of the differential ebullioscope. The apparatus described in an earlier communication can be applied with advantage to distinguish between a pure substance and an azeotropic mixture.—**Mlle. Germaine Marchal**: The action of silica and alumina on sodium sulphate. The decomposition of sodium sulphate at high temperatures, up to 1300° C., is accelerated by the addition of silica or alumina.—**R. Levaillant**: Neutral isopropyl sulphate and normal propyl sulphate—**P. Fallot**: The structure of the sub-Betic zone between Moratalla and the Betic zone.—**Porchet**: A method for the determination of the base of a subterranean sheet by observations of the variations of its free surface.—**Mlle. Panca Eftimiu**: The karyokinesis of *Spathularia flavida*.—**Edouard Papin**: The vesico-uteral reflex.—**Charles Pérez**: Sexual differences in the ornamentation and in the pigmentary system in *Macropodia rostrata*.—**Edouard Chatton, Mme. Marguerite Lwoff, and André Lwoff**: The prepalintomic and metapalintomic metamorphoses of the Fœttingeriidæ (ciliated).—**Mme. Phisalix and F. Pasteur**: The action of the ultra-violet rays on the virus of rabies and its rabic and poisonous antigens.—**A. Policard, S. Doubrow, and D. Pillet**: Histochemical researches on pulmonary anthracosis. Results obtained by the application of the method of microincineration to sections of lung tissue.—**R. Leriche and R. Fontaine**: The rôle of the left stellated ganglion in the determination of the crisis of angina pectoris.

ROME.

Royal National Academy of the Lincei: Communications received during the vacation.—**L. Lombardi and P. Lombardi**: Measurement of the local dissipations of energy within a circumscribed part of the magnetic circuit (3). The method and apparatus previously described are found to be applicable to the measurement, with sufficient approximation, of the losses of power in a circumscribed portion of the magnetic circuit, even if these do not exceed a few watts, provided that there are available an electro-dynamometer of convenient sensitiveness, a condenser affected by slight retardation of polarisation, and a source of electromotive force approaching the sinusoid form or reactance capable of rendering the form of the magnetising current approximately sinusoid. Failure of the last condition introduces into the numerical interpretation of the measurement an error which increases with the saturation, not unlike that with which ordinary wattometric methods would be affected if the loss were referred to the maximum values of the induction in the absence of exact knowledge of the form factor of the tension applied.—**T. Boggio**: Three dimensional space curves and Ricci's homograph.—**Maria Pastori**: Commutation formulæ in the derivation of tensors. The existence is demonstrated of a general commutation formula of covariant (or intrinsic) derivatives of higher order, including, as a particular case, the known formula for the second derivatives.—**H. Geppert**: The adiabatic invariants of a differential generic system (2).—**W. Slebodzinski**: Deformations in a variety of constant curvature.—**G. Sansone**: Determination of the number of the congruences $x^2+ax+a=0$ (mod. p) having three roots with the same quadratic character modulus p.—**J. Kanitani**: A geometrical interpretation of the linear projective element of the hypersurface.—**B. Finzi**: Kutta-Joukowski's theorem. Signorini's recent demonstration of Kutta-Joukowski's theorem does not remove the exceptional case pointed out by Cisotti, which is now shown to be subordinate to the conditions of regularity at the contour.—**P. Emanuelli**: Non-central total eclipses of the sun. Of the nineteen eclipses of this type occurring between 1200 B.C. and A.D. 2100, five take place in the northern and fourteen in the southern regions, eight at the beginning and eleven at the end of the second series. In every case, with the exception of that of 261 B.C., the non-central total eclipse is either preceded by a central and followed by a partial eclipse, or preceded by a partial and followed by a central eclipse. The conditions of the nineteen eclipses are discussed.—**B. Rossi**: The distribution of electricity in conductors immersed in a homogeneous anisotropic medium. It has been shown recently that the distribution of electricity on a conducting ellipsoid immersed in an indefinite homogeneous anisotropic dielectric is independent of the dielectric homograph of the medium and coincides with that exhibited when the dielectric is isotropic. It is now found that the distribution of electricity on the surface of a conductor is not dependent on the dielectric homograph of the medium (supposed homogeneous) only when the conductor itself has the form of an ellipsoid (or, in particular, a sphere) and when other conductors are absent from the field.—**G. Gentile and E. Majorana**: The separation of the Rontgen and optical terms owing to the spinning electron, and the intensity of the cæsium lines. Fermi's potential not only permits a good *a priori* determination of all the energy levels of heavy atoms, but, given the statistical character of this theory of the atom, also allows of very exact calculation of the separation of the terms.—**L. Fernandes**: Thio-salts (7). Polythiovanadates. The author's investigations on complex thio-salts, especially on thioaquates, are extended to the products of the polymerisation of the thiovanadates; various ammonium, guanidine, and thallium salts are described.—**A. Ferrari and A. Inganni**: The importance of the crystalline form in the formation of solid solutions (3). Thermal analysis of the anhydrous systems: $MnCl_2-CoCl_2$, $CdCl_2-CoCl_2$, and $MgCl_2-CoCl_2$. These three systems exhibit miscibility in the solid state in all proportions of the components. The curves showing the temperatures at which solidification begins present neither maxima nor minima.—**E. Onorato**: The sulphur deposit of Monte Solforoso, near Scrofano, in the province of Rome.—**Enrico Clerici**: Applicability of isopyknomeric analysis to auriferous rocks. Observations made on auriferous rocks of various origins show that the presence of native gold, even in as small a proportion as 0·5 gram per ton, may be rapidly detected by means of isopyknomeric analysis.—**M. Comel**: Analysis of the oxygen absorption curve of muscle pulp as a function of the hydrogen ion concentration. Further investigations on the gaseous metabolism of frog muscle pulp in equilibrating phosphate solutions yield an oxygen absorption curve indicating three zones of gaseous metabolism, delimited by two points of inflection, the first corresponding with values of pH grouped about the neutrality point and extending, on the acid side, to the value 6·6. As lower values of pH are reached, the metabolism exhibits considerable diminution, the zone between 6·6 and 6·0 being one of medium metabolism, which ends in conditions approximating to physiological conditions. For values below 6·0, metabolism rapidly falls and becomes zero at 5·3, muscular proteins ceasing to absorb oxygen in the neighbourhood of their isoelectric point.—**L. De Caro**: Energy of growth of *Sterigmatocistis Nigra*. The

'energy of preservation' of this organism is measured directly by determining the carbon dioxide developed by the mycelium when it is transferred to a nutrient liquid devoid of phosphate. The lack of phosphate inhibits further growth, so that the carbon dioxide liberated under these conditions expresses the consumption of energy inherent to the preservation of life in the cells formed. This energy from the commencement of its formation to the 72nd hour, amounts to 1·407 Calories. Knowledge of this value allows of the calculation of the real energy of growth, which is somewhat greater than that calculated on different lines for *Aspergillus niger* by Terroine and Würmser, and is of the same order of magnitude as the energy of growth in the development of the egg.

VIENNA.

Academy of Sciences, Nov. 2.—E. A. W. Schmidt: The half-period of radium-D. About twenty-five years.

Nov. 8.—L. Moser and K. Schutt: Determination and separation of rare metals from other metals. (12) Separation of lithium from potassium, sodium, and magnesium. Better than the fluoride and phosphate methods are those which depend on the solubility of dry lithium chloride in water-free organic solvents such as iso-butyl alcohol. Lithium is separated from magnesium by precipitating the magnesium by *o*-oxy-quinoline.—E. Heinricher: Anomalous blossoms of the crown-imperial (*Fritillaria imperialis*). One race is sexually sterile, another race is sexually fertile but self-sterile.

Diary of Societies.

FRIDAY, FEBRUARY 15.

GEOLOGICAL SOCIETY OF LONDON, at 3.—Annual General Meeting.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 4.30.—Geophysical Methods in Surveying. Chairman: Sir Gerald Lenox-Conyngham. Speakers: Mr. Broughton-Hedge, Dr. W. F. P. McLintock, and others.

BRITISH INSTITUTE OF RADIOLOGY (Medical Members), at 5.—Informal Discussion on Chest.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. H. A. Harris: Bone Growth in Health and Disease.

INSTITUTION OF MECHANICAL ENGINEERS (Annual General Meeting), at 6.—H. J. Ward: Refrigeration on Shipboard.

INSTITUTE OF TRANSPORT (at Midland Hotel, Manchester), at 6.30.—C. D. Campbell: Inland Water Transport.

SOCIETY OF DYERS AND COLOURISTS (Manchester Section, jointly with Manchester Section of Oil and Colour Chemists' Association) (at Literary and Philosophical Society, Manchester), at 7.—F. Scholefield: The Ostwald Colour System.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group—Informal Meeting), at 7.—Discussion on the Stephan H. Tyng Foundation Prints.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (jointly with all Glasgow Chemical Societies) (at 207 Bath Street, Glasgow), at 7.30.—Prof. G. T. Morgan: Chemical Studies of Coal-Tar Products.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—E. G. Ritchie: Steam Storage.

ROYAL SOCIETY OF MEDICINE (Obstetrics Section), at 8.—Prof. J. Heyman: The Uses of Radium in the Treatment of Malignant Disease of the Uterus and Ovaries.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Discussion on Chronic Rheumatism of Joints and Muscles: Diagnosis and Treatment.—Opening Papers:—Dr. D. D. Maplas: Radiological Diagnosis; Dr. C. W. Buckley. Spa Electro-therapy; Dr. F. D. Howitt: Electro-therapy.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. E. K. Rideal: Chemiluminescence

ROYAL AERONAUTICAL SOCIETY (Yeovil Branch).—Dr. E. G. Richardson: Modern Aerofoil Experiments (Lecture).

SATURDAY, FEBRUARY 16.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Yorkshire District) (at Beverley), at 11.15.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates' and Students' Section) (at Newcastle-upon-Tyne), at 2.30.—L. H. Forster: The Lubrication of Colliery Coal Tubs.

PHYSIOLOGICAL SOCIETY (in Physiological Laboratory, University, Birmingham), at 3.—J. C. Bramwell and R. Ellis: The Crescendo Murmur in Mitral Stenosis.—Lilian M. Pickford and Dr. E. B. Verney: Renal Adaptation.—Prof. J. Barcroft and H. Florey: Comparison of Vascular Changes in Spleen and in Small Intestine.—W. V. Thorpe: A Vasodilator Substance in Heart Muscle.—I. de Burgh Daly: An Attempt to Measure the Blood-Capacity of the Pulmonary Capillaries.—Demonstrations:—W. V. Thorpe: (*a*) Small Hot-Funnels; (*b*) Small Tissue Press.—J. C. Brash: Specimens from Madder Fed Animals Illustrating Bone Growth.—H. M. Fox: Constant Pressure Apparatus for Recording the O_2 Intake of Small Animals Adapted for Class Purposes.—D. L. Gunn: Apparatus for Studying the Reactions of Insects to Temperature and Humidity Changes.—I. de Burgh Daly: (*a*) A Simple Arrangement for Making the Closed Circuit Heart Lung Preparation under Negative Pressure Ventilation; (*b*) A Model Illustrating some of the Effects of Respiration upon the Pulmonary Blood Vessels.—W. R. McRobert: Siderosis of the Spleen in the Resting and Exhausted Rat.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. E. Bullock: Music in Cathedral and Collegiate Churches (II.).

BRITISH PSYCHOLOGICAL SOCIETY (at Royal Anthropological Institute), at 3.—J. C Flugel and Miss Eve Macaulay: The Psychology of Clothes in Adults and Children: Some Results by the Questionnaire Method.

EUGENICS SOCIETY (at Rembrandt Hotel, Brompton Road), at 7.15.—Major L. Darwin: The Coming of Age of the Eugenics Society (Galton Lecture)

MONDAY, FEBRUARY 18.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Lieut.-Col. T. C. Skinner The Ice Age: its Astronomical Cause and the Bearing of Drayson's Discovery on the Biblical Account of the Deluge.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates Section), at 6 30.—G. Bird: Railway Brakes.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—R. L. Morrison and others: Discussion on Modern High Power Rectifiers. their Development and Use.

INSTITUTE OF CHEMISTRY (Leeds Area Section) (jointly with Society of Public Analysts—North of England Section) (at Great Northern Hotel, Leeds), at 7.15.—C. H. Manley and others: Discussion on The Preservatives Regulations, 1925–1927.

BRADFORD TEXTILE SOCIETY (at Midland Hotel, Bradford), at 7.30.—P. E. King. Artificial Silk: its Expansion in the Textile Industries (Lecture).

HUDDERSFIELD TEXTILE SOCIETY (jointly with Huddersfield Engineering Society) (at Huddersfield Technical College), at 7.30.—Dr. W. Hatfield: The Application of the Special Acid Resisting Steels to the Textile Industry.

INSTITUTION OF AUTOMOBILE ENGINEERS (Glasgow Centre) (at Royal Technical College, Glasgow), at 7.30.—H. K. Thomas: Some Investigations into the Performance of Tubular Radiators for Motor Vehicles

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—J. A. Gotch: Modern Banks, with Special Reference to the New Midland Bank Head Office.

ROYAL SOCIETY OF ARTS, at 8.—Sir Thomas M. Legge: Thirty Years' Experience of Industrial Maladies (Shaw Lectures) (I.).

INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Section) (and Society of Chemical Industry—Edinburgh and East of Scotland Section) (at North British Station Hotel, Edinburgh), at 8.—S. D Forrester: Potentiometric Bromination of Naphthol Sulphonic Acids.—J. G. Mackay: The Estimation of Sulphur in Rubber.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—G. Binney: Hudson Bay in 1928.

TUESDAY, FEBRUARY 19.

ELECTRICAL ASSOCIATION FOR WOMEN (at 159 Great Portland Street), at 3.—The Construction, Use, and Maintenance of Electric Sewing Machines.

ROYAL DUBLIN SOCIETY (in Science Room, Ball's Bridge, Dublin), at 4.15.—Prof. F. E. Hackett and others: Discussion on The Changing Outlook on Physical Science.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof J. S. Huxley: Evolution and the Problem of Species (IV.)

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—Dr. A. B. Hill: The Investigation of Sickness in Various Industrial Occupations.

ROYAL SOCIETY OF MEDICINE, at 5 30.—General Meeting.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the Month of January 1929.—Lieut.-Col. A. E. Hamerton: Report on the Deaths occurring in the Society's Gardens during 1928.—Lilian Russell: The Comparative Morphology of the Elysioid and Æolidioid Types of the Molluscan Nervous System and its Bearing on the Relationships of the Ascoglossan Nudibranchs.—Dr. M. Evans: Some Notes on the Anatomy of the Electric Eel, *Gymnotus electrophorus*, with Special Reference to a Mouth-breathing Organ and the Swim-bladder.—C. B. Kloss: Some Remarks on the Gibbons, with the Description of a New Subspecies.—B. N. Schwanwitsch: Studies on the Wing-pattern of *Cotagramma* and Related Genera of South American Nymphalid Butterflies.—Jnanendra Lal Bhaduri: The Persistence of a Left Posterior Cardinal Vein and the Presence of an Abnormal Vein opening into the Isthmus of the Liver in an Indian Toad.—Dr. G. D. Hale Carpenter: Further Notes on the Fauna of Nkosi Island, Lake Victoria.

INSTITUTION OF CIVIL ENGINEERS, at 6.—A H Barker: The Electrical Heating and Ventilation of Bourne and Hollingsworth's Premises, Oxford Street.

LONDON NATURAL HISTORY SOCIETY (at Winchester House, E.C.), at 6.30.—L. G. Payne, E. B. Bishop, and others: Debate: Are the Artificial Introduction of New Species and the Formation of New Localities for Existing Species of the British Flora Justifiable?

ILLUMINATING ENGINEERING SOCIETY (in Lecture Theatre, Home Office Industrial Museum, Horseferry Road), at 6 45.—Discussion on Various Problems in Illuminating Engineering:—S. G Elliott: The Lighting of the New Piccadilly Underground Station.—E. Stroud: The Lighting of the Royal Horticultural Hall.—G. Herbert: The Lighting of a New Factory in London with over 1000 Units.—R. A. Ives: The Lighting of the Wembley Kinema Theatre.—L. E. Buckell: An Example of Daylight Effects obtained with Artificial Light.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—W. Cruickshank: Voice-Frequency Telegraphs.

INSTITUTE OF METALS (Birmingham Local Section) (jointly with Birmingham Metallurgical Society and Staffordshire Iron and Steel Institute) (at Engineers' Club, Birmingham), at 7.—E. C. Evans: Fuel.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.30.—Ll. B. Atkinson How Electricity does Things (Faraday Lecture)

INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Centre) (at Engineering and Scientific Club, Wolverhampton), at 7.30.—H. K. Thomas: Some Investigations into the Performance of Tubular Radiators for Motor Vehicles.
MANCHESTER ATHENÆUM TEXTILE SOCIETY (at Manchester College of Technology).—Dyeing (Lecture).

WEDNESDAY, FEBRUARY 20.

ROYAL METEOROLOGICAL SOCIETY, at 5.—L. H. G. Dines: The Baker Automatic Release for Dropping the Meteorograph from a Registering Balloon at a Predetermined Height.—C. K. M. Douglas: Some Aspects of Surfaces of Discontinuity.—Dr. E. Kidson and H. M. Treloar: The Rate of Ascent of Pilot Balloons at Melbourne.
GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. C. A. Matley: The Basal Complex of Jamaica, with Special Reference to the Kingston District, with Petrological Notes by F. Higham.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 6.—G. E. W. Herbert: In and Out of Bruges.
INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Newcastle-upon-Tyne), at 7.15.—W. G. Thompson: Some Unusual Aspects of Combustion in Engines and Boilers
INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Graduates) (at Queen's Hotel, Birmingham), at 7.30.—E. M. Frank: Valve Gear for High-speed Singles
SOCIETY OF CHEMICAL INDUSTRY (Nottingham Section) (jointly with Society of Dyers and Colourists) (at University College, Nottingham), at 7.30.—A. Stowers: Steam Storage as an Aid to Economy in the Dye-House.
INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—Lt.-Col. K. Edgcumbe: Address.
GLASGOW UNIVERSITY ALCHEMISTS' CLUB (at Glasgow University), at 7.30. —Prof. Kendall: The Abuse of Water.
ROYAL SOCIETY OF ARTS, at 8.—J. Morton: History of the Development of Fast Dyeing and Dyes.
FOLK-LORE SOCIETY (Annual Meeting) (at University College), at 8.—Prof. R. M. Dawkins: Folk-Lore and Literature (Presidential Address).
ROYAL MICROSCOPICAL SOCIETY, at 8.—Dr. R. G. Canti and F. G. Spear: Some Effects of Radium on Cell Division *in vitro*.—S. F. Fox: Some Effects of X-Rays on Cell Division *in vitro*.—F. G. Spear: An Effect of Low Temperature on Cell Division *in vitro*.—Demonstrations:—S. F. Cox: The Effect of a Heavy Dose of X-Rays on Living Cells as shown by the Dark-Ground Method.—Dr. R. G. Canti: Demonstration of Cell Division in the Living Tissues cultivated *in vitro*
HASLINGDEN TEXTILE SOCIETY.—J. W. Pennington: The Position of Artificial Silk in Relation to the Cotton Industry.

THURSDAY, FEBRUARY 21.

ROYAL SOCIETY, at 4.30.—P. Kapitza: The Change in Electrical Conductivity in Strong Electric Fields. Parts I. and II.—R. R. Nimmo and N. Feather: An Investigation of the Ranges of the Long Range α-Particles from Thorium C and Radium C using an Expansion Chamber. —C. R. Burch: Some Experiments on Vacuum Distillation.—*To be read in title only*:—Prof. E. C. C. Baly and N. R. Hood: The Photosynthesis of Naturally Occurring Compounds (IV.).—R. Alty and B. W. Currie: Adsorption at a Water Surface (I.).—W. G. Palmer: Some Adsorption Isothermals for a Plane Platinum Surface.—B. Lambert and A. M. Clark: Studies in Gas-Solid Equilibria.—G. C. Laurence: Relative Velocities of the Alpha-Particles emitted by certain Radioactive Elements.—H. W. Thomson and C. N. Hinshelwood: The Mechanism of the Homogeneous Combination of Hydrogen and Oxygen.—E. G. Dymond and E. E. Watson: Electron Scattering in Helium.—E. T. Hanson: Diffraction and Resonance.—S. Goldstein: (*a*) The Forces on a Solid Body Moving through Viscous Fluid; (*b*) The Steady Flow of Viscous Fluid past a Fixed Spherical Obstacle at Small Reynolds Numbers.—J. Taylor: On the Chemical Interaction of Ions and the 'Clean up' of Gases at Glass Surfaces under the Influence of the Electrical Discharge.—L. Hartshorn and D. A. Oliver: On the Measurements of the Dielectric Constants of Liquids, with a Determination of the Dielectric Constant of Benzene.—J. W. Fisher: The Wave Equation in Five Dimensions.—Prof. H. M. Macdonald: The Total Reflexion of Electric Waves at the Interface between two Media.—K. Lonsdale: The Structure of the Benzene Ring in $C_6(CH_3)_6$.—Dr. E. Griffiths and J. H. Awbery: Measurements of Flame Temperatures.
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. A. O. Rankine: Physics in Relation to Oil Finding (I.).
INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30
SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Birmingham University), at 7.—Prof. W. N. Haworth: Recent Views on the Structure of Cellulose and Starch.
INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates) (at Watergate House, Adelphi), at 7.25.—C. Russell: Some Notes on Gear Production.
INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre—Dublin) (at Trinity College, Dublin), at 7.45.—Dr. K. Ott: The Erection of the Mechanical and Electrical Part of the Shannon Scheme.
CHEMICAL SOCIETY, at 8.—Dr. R. G. W. Norrish: (*a*) Photochemical Equilibrium in Nitrogen Peroxide. Part II. The Dependence of Quantum Efficiency on Wave Length. (*b*) Part III. A Comparison of the Thermal, Photochemical, and Electrical Decompositions, and a General Theory of the Change (*c*) Part IV. Fluorescence and Photochemical Activity.—A. T. Dann and W. Davies: The Reactions of Nitrosulphonylchlorides. Part I. The Reaction of Hydrazine Hydrate with o-nitrosulphonyl Chlorides.
ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.), at 8.15.—Dr. L. W. Hackett: Malaria-Control through Anti-Mosquito Measures in Italy.
INSTITUTION OF MECHANICAL ENGINEERS (Midland Branch) (at Birmingham).—Chairman's Address.

FRIDAY, FEBRUARY 22.

IMPERIAL COLLEGE CHEMICAL SOCIETY (in Main Chemistry Lecture Theatre, Royal College of Science), at 5.—Dr. F. A. Freeth: The Qualifications of an Industrial Chemist.
PHYSICAL SOCIETY (at Imperial College of Science), at 5.—L. F. Stanley: The Construction and Calibration of a Sensitive Form of Pirani Gauge for the Measurement of High Vacua.—Prof. C. H. Lees: The Free Periods of a Composite Elastic Column or Composite Stretched Wire.—Dr. A. Ferguson and J. A. Hakes: A Capillary Tube Method for the Simultaneous Determination of Surface Tension and of Density.—Demonstration of a Standard Electrostatic Voltmeter and Wattmeter, used for Measurements of Alternating Currents at Power Frequencies at the National Physical Laboratory, by Dr. E. H. Rayner.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in Mining Institute, Newcastle-upon-Tyne), at 6.—Dr. G. W. Todd: The Relation between the Properties of Engineering Materials and their Ultimate Structures.
INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section) (jointly with Institutions of Civil and Mechanical Engineers), at 6.15.—W. Ford: Standardisation.
ROYAL AERONAUTICAL SOCIETY (Students' Section), at 6.30.—L. T. Brown: The Napier Lion Engine.
MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section), at 7.
INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—G. Baker: Electrical Precipitation.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—G. C. Weston: Enlarging.
WEST OF SCOTLAND IRON AND STEEL INSTITUTE (at Royal Technical College, Glasgow), at 7.—Dr. W. H. Hatfield: The Response of Steels at Elevated Temperatures.
BLACKBURN TEXTILE SOCIETY (at Blackburn Technical College), at 7.30.—W. A. Walsh: Some Recent Improvements in Textile Machinery (Lecture).
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—J. Calderwood: The Application of the Heavy Oil Engine to Yachts and Small Craft.
ROYAL SOCIETY OF MEDICINE (Epidemiology Section), at 8.—Surg.-Comdr. S. F. Dudley: Human Adaptation to the Parasitic Environment.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. F. A. Bather: Lily-Stars of the Sea: How they fit their Surroundings.
INSTITUTION OF MECHANICAL ENGINEERS (Manchester Branch).
TODMORDEN TEXTILE SOCIETY.—S. Taylor: Winding and Warping (Lecture).

SATURDAY, FEBRUARY 23.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. E. Bullock: Music in Cathedral and Collegiate Churches (III.).

PUBLIC LECTURES.

FRIDAY, FEBRUARY 15.

LONDON SCHOOL OF ECONOMICS, at 5.—C. E. R. Sherrington: Motor Transport and Urbanisation of the Countryside.
SURVEYORS' INSTITUTION, at 5.30.—G. Atkinson: Salvaging the Fleet at Scapa Flow (Lecture in connexion with the Institution of Professional Civil Servants).

SATURDAY, FEBRUARY 16.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss I. D. Thornley: Travel and Travellers in the Middle Ages.

MONDAY, FEBRUARY 18.

KING'S COLLEGE OF HOUSEHOLD AND SOCIAL SCIENCE, at 5.15.—J. A. Spender: America and British-American Relations.
KING'S COLLEGE, at 5.30.—Prof. R. R. Gates: Botanical and Anthropological Explorations in the Canadian Arctic.
EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—Prof. N. M. Comber: Soil Problems.

TUESDAY, FEBRUARY 19.

BIRKBECK COLLEGE, at 5.30.—Sir Charles Oman: The History of the Coinage of England. (Succeeding Lectures on Feb. 26 and Mar. 5.)
UNIVERSITY COLLEGE, at 5.30.—Prof. Ethel M. Elderton: Growth Curves in Women from Childhood to Old Age.
UNIVERSITY OF LEEDS, at 8.—Prof. W. E. Soothill: China's Contribution to Western Civilisation.

WEDNESDAY, FEBRUARY 20.

INSTITUTION OF ELECTRICAL ENGINEERS, at 5.30.—L. Emanueli: High Voltage Cables. (Succeeding Lectures on Feb. 22, 26, Mar. 1 and 5.)

THURSDAY, FEBRUARY 21.

EAST LONDON COLLEGE, at 5.30.—Dr. C. H. Lander: The Burning of Fuel: Solid, Liquid, and Gaseous.
UNIVERSITY COLLEGE, at 6.—Col. G. S. C. Cooke: The Ordnance Survey—its Work and Maps.

FRIDAY, FEBRUARY 22.

LONDON SCHOOL OF ECONOMICS, at 5.—C. E. R. Sherrington: Air Transport and the Disintegration of Economic Barriers.
UNIVERSITY COLLEGE, at 5.30.—Dr. J. H. Jones: Hygiene of the Mercantile Marine. (Succeeding Lectures on Mar. 1 and 8.)

SATURDAY, FEBRUARY 23.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. Barnard Smith: Zermatt and its Glaciers.

EXHIBITION.

FEBRUARY 19 TO MARCH 16.

UNIVERSITY COLLEGE.—Exhibition of Recent Work in British Archæology. Public Lectures in connexion with the Exhibition:—
Tuesday, Feb. 19, at 5.30.
C. R. Peers: Archæology and the State.
Wednesday, Feb. 27, at 5.30.
Prof. R. A. S. Macalister: Recent Archæological Work in Ireland.
Wednesday, Mar. 6, at 5.30.
Dr. C. Fox: Recent Archæology in Wales and its Borders.

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The Position of British Veterinary Education and Service.

THERE has just been issued the Report of a Committee appointed by the Secretary of State for the Colonies to inquire into the conditions of the Colonial Veterinary Service (H.M.S.O., Cmd. 3261. Price 9*d*. net). The Committee, which was presided over by Lord Lovat, was asked to frame proposals for obtaining the highest degree of efficiency in regard to veterinary research and administration in the non-self-governing dependencies that financial considerations permit. The questions considered and reported upon include the recruitment and training of veterinary officers, their conditions of service, the organisation of research and intelligence and the setting up and support of any institutions required. The entire field has apparently been very thoroughly explored and the report makes illuminating and very disquieting disclosures of the great difficulties under which veterinary education and training are carried out in Great Britain. Referring to the dilapidated condition of the Royal Veterinary College at Camden Town, the Committee says :

"It is nothing short of a national disgrace that such a condition of affairs should be allowed to continue. The blame does not lie with the teaching staff, labouring as they do under the great disadvantage of inadequate salaries in a school which is both inadequately staffed and equipped. On the contrary, they have made great personal sacrifices, and have themselves provided much of the existing equipment."

Indeed, it is within our knowledge that on more than one occasion in years of financial strain the teaching staff of the College have submitted to a considerable reduction of their already inadequate salaries, and that at times when most salaried officials, such as those of the Civil Service, were in receipt of a yearly bonus on account of the increased cost of living.

"Veterinary schools in this country receive but little help from the State and have to rely mainly on students' fees. When we compare the large veterinary institutions in other countries, supported principally by State funds, with those that exist in Great Britain, the contrast is somewhat depressing."

The Veterinary College of Berlin receives an annual grant from the State of £28,000, while, since the War, a new veterinary college has been built at Leipzig at a cost of more than £1,000,000. It is not to be wondered at, therefore, that the Committee is convinced that existing conditions

in Great Britain and overseas "should no longer be tolerated." A new policy, on comprehensive lines and with adequate financial support, is needed and should be carried out boldly.

Veterinary activities can no longer be limited to the mere treatment of specific diseases or even the prevention of epizoötic and enzoötic diseases. The advance of agriculture—the staple industry of almost all the dependencies of the British Empire—is closely associated with animal husbandry in its widest sense, and animal nutrition and animal genetics are of the highest economic importance, while the successful development of public health involves problems of improved milk and meat supply. Moreover, the advance of modern medical science—so largely the result of observations on animals—requires the continuous collaboration of veterinarians in the solution of such problems as insect-borne diseases like the trypanosomiases or the virus diseases.

The economic aspect of stock-rearing alone would justify the provision of adequate measures for combating animal diseases and improving the health and nutrition of the flocks and herds. Between 1914 and 1925 the cattle population of Nigeria was reduced by as much as 25 per cent, almost entirely through rinderpest. This same disease in two outbreaks destroyed 5,000,000 head of cattle in South Africa south of the Zambezi, representing a loss of £20,000,000.

The Lovat Committee is of opinion that the veterinary departments of the colonies are generally understaffed and that the conditions of service do not attract enough recruits of the type required, such as those combining technical proficiency with the personal qualities which are essential if the veterinary officer is to enforce his often disturbing regulations without undue friction. The colonies must make their veterinary services more attractive. The status and prestige and conditions of service of veterinary departments must be improved, and it will be necessary to offer higher salaries, particularly in the senior grades.

The present veterinary course of training in Great Britain, with the standard of preliminary general education identical with that demanded by the General Medical Council, consists of a four years' (membership diploma) or a five years' (university degree) course, with post-graduate courses for additional diplomas. There is no special training, however, in tropical veterinary science comparable with that provided for candidates for the colonial medical services at the schools of tropical medicine, and the Committee recommends that all newly appointed officers should undergo in Great Britain a course of instruction in tropical veterinary science before proceeding overseas.

If the recommendations of the Lovat Committee are adopted, the veterinary services will no longer be regarded as the Cinderella of the services, and opportunities will be afforded for utilisation of the best types of recruits for veterinary research. As Sir Arnold Theiler recently stated in referring to such matters, British veterinarians have brain and ability second to none in the whole world if they are only afforded the opportunity of applying them.

To remedy this condition of affairs, it is recommended that fundamental veterinary education in Great Britain must be supported in such a way that the stigma of a "national disgrace" shall be removed, and that a system of scholarships be instituted to attract more men with a scientific training and with an aptitude for research. There should also be a special post-graduate training, for which purpose there should be established a school of tropical veterinary science modelled on the lines of the London School of Tropical Medicine, and it should be closely linked with a veterinary college and affiliated to a university so as to be eligible for a grant from the University Grants Committee.

To complete its work, the Committee has made striking recommendations for the provision of headquarters organisations, the organisation of research with the establishment of a central research station adequately equipped and staffed, and the provision of a Colonial Veterinary Service available for service in any part of the Colonial Empire and not limited to any particular colony. In regard to this service the Committee says: "The veterinarian of the highest ability will enter the Colonial Services only if he is offered a career sufficiently attractive in pay and prospects to satisfy his ambitions as a scientific worker."

Much of this report cannot but be of considerable assistance to the departmental committee appointed by the Minister for Agriculture, sitting, at present, to inquire into the requirements for veterinary education in Great Britain, with particular reference to the Royal Veterinary College, Camden Town, and we earnestly hope that, as the result of recommendations of two such strong committees, the "national disgrace" at Camden Town will be reconstituted and endowed in such a manner as to become a credit as the senior and most important veterinary college of the British Empire.

Invertebrate Fauna of Rapid Waters.

Contribution à l'étude des invertébrés torrenticoles. Par Dr. Étienne Hubault. (Suppléments au *Bulletin biologique de France et de Belgique*, Supplément 9.) Pp. 388 + 10 planches. (Paris : Les Presses universitaires de France ; London : Dulau and Co., 1927.) 85 francs.

FRESH-WATER biology, much neglected in the past, is rapidly becoming the subject of intensive and valuable study. Until recently the majority of investigators into such problems as adaptation, evolution, migration, and geographical distribution have turned largely to the sea for material. But these phenomena are exemplified in almost, if not quite as marked a degree, by the more accessible inhabitants of fresh waters as by the denizens of the deep. Vast lake and tiny pool, clear spring and stagnant pond, rushing stream and trickling rivulet—each has its own characteristic inhabitants specially adapted for life under the particular set of environmental conditions found therein. Moreover, as in the sea, each of these principal types of habitat, such as hill streams, contains within itself numerous subsidiary types of habitat differing fundamentally one from another, and each harbouring its own particular group of organisms.

Specially welcome, therefore, is Dr. Hubault's contribution to the study of the invertebrate fauna of rapid waters. This most exhaustive work of superlative value is at once systematic, physiological, and biological. The systematic portion of the work consists of an enumeration of the organisms actually studied and collected by the author in the course of his researches, with a table showing the general distributions of all the species determined with certainty. The physiological portion includes in its scope detailed observations on the temperature, salinity, and oxygen content of the waters of hill streams, and the parts played by these factors in determining the distribution of a hill stream fauna.

The last-named factor Dr. Hubault has made the subject of detailed investigation, especially with regard to the distribution of oxygen in the different parts of hill streams, and the annual rhythm of this distribution. He finds that, near the source, the water is always rich in dissolved oxygen—slightly less so in summer than in winter, but the difference is negligible. In the lower reaches, on the contrary, there is a marked seasonal variation, the water being poor in dissolved oxygen during the warmer months and relatively rich during the colder months of the year. Thus, in summer there is a considerable difference between the oxygen content of the upper and lower reaches of rivers and streams, while in winter the uniformly cold waters are throughout rich in oxygen. Nevertheless, although there is little or no seasonal variation near the source, there is a noticeable 'diurnal oscillation' of oxygen concentration, the volume of water here being small, and considerable diurnal change of temperature taking place. The concentration reaches a maximum about sunrise, and falls to a minimum shortly after mid-day. Change of temperature alone is held to be responsible for this daily rhythm, phytoplankton being non-existent, and other aquatic vegetation scanty. Farther down where the volume of water is greater, the temperature remains practically uniform throughout the twenty-four hours, and there is no 'diurnal oscillation' of oxygen concentration.

A striking example is given of the effect of the action of aerobic bacteria in reducing the oxygen content of water, and thus constituting a very real menace to the life of higher organisms. On the banks of the small stream Saint-Benoît there are, at one place about the middle of its course, four potato-starch factories situated a short distance apart. In November 1924 the difference in oxygen concentration immediately above and below these factories was 1·55 c.c. per litre, in spite of the fact that the stream was then in flood. In October 1925 the stream was normal and, although only three factories were working, the difference above and below them was 1·73 c.c. per litre.

Correlated with these investigations on oxygen concentration and distribution, the author has determined the oxygen consumption of various organisms from different fresh-water habitats. He finds that forms found in rapidly running or other waters more or less uniformly cold throughout the year have, in general, a higher oxygen consumption than those found in waters such as slowly moving streams, where the temperature rises considerably in summer. The amount of dissolved oxygen present in the water is therefore an exceedingly important factor in determining the distribution of the inhabitants of fresh waters.

In this connexion Dr. Hubault lays great emphasis on the fact that, in the life of the inhabitants of rapid waters, the actual current plays only a secondary rôle, the primary conditions governing their existence being such factors as temperature, salinity, and, more particularly, oxygen concentration. Only in running waters do these organisms find those physico-chemical conditions which are essential to them. Of necessity,

therefore, they must 'put up with' the current—an inconvenient mechanical force which they have overcome with varying degrees of success by means of a remarkable series of tropisms and morphological adaptations, ranging from those exhibited by the most highly specialised forms adapted for life in cascades and waterfalls, down to the very slight modification of such as, although living in streams, ensconce themselves amongst moss or under stones where the current is little felt. Chapter v. is devoted to the study of tropisms, especially the three principal tropisms exhibited by these hill stream organisms—rheotropism, stereotropism, and phototropism with its corollary, nycthemeral rhythm—upon which the author has made extensive observations.

Chapter vi. deals mainly with the biology of the Trichoptera and Blepharoceridæ. The former group is considered only in outline, the latter more fully, the author having focused his attention particularly upon *Liponeura vogesiaca* nov. sp., the biology of which he has followed out in detail in the upper courses of the river Meurthe in the High Vosges.

Finally, Dr. Hubault passes in review the evidence bearing upon the origin of a rapid water fauna. An extensive bibliography of more than three hundred references completes the work.

G. A. S.

Progress of Research in Tropical Medicine.

(1) *An Introduction to Medical Protozoology: with Chapters on the Spirochætes and on Laboratory Methods.* By Lieut.-Col. Robert Knowles. Pp. xii + 887 + 15 plates. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co., 1928.) Rs. 25.

(2) *Recent Advances in Tropical Medicine.* By Sir Leonard Rogers. Pp. viii + 398. (London: J. and A. Churchill, 1928.) 12*s.* 6*d.* net.

IN a little more than a quarter of a century the patient and often brilliant researches of numerous scientific workers have elucidated many difficult problems regarding the causes and dissemination of diseases so prevalent in the tropics. The parasites of malaria, sleeping sickness, relapsing fever, amœbic and bacillary dysentery, cholera, plague, and leprosy are now readily detected. It is perhaps of even greater importance that in many instances the life histories and transmission of these organisms to man have been clearly demonstrated.

Such discoveries have placed in the hands of the hygienist methods of control against the spread of disease, which in time will convert huge tracts of valuable territory previously known by such names as 'the white man's grave' into veritable health resorts.

Our present knowledge regarding some of these diseases might seem to be ample and complete, but there is no finality, as is exemplified by the continued careful investigations which are being carried on all over the world. New facts regarding the parasites and the bionomics of their vectors are being slowly accumulated, and many unknown factors await elucidation in order to place the control of such diseases as malaria or sleeping sickness over large areas of the tropics on an economic basis.

(1) A striking example of the growth of knowledge regarding diseases of man and other animals is afforded by the publication of the substantial volume before us entitled "An Introduction to Medical Protozoology." Here Lieut.-Col. Knowles, in an interesting manner and in a style peculiarly his own, describes those unicellular animals which parasitise man. The most interesting chapters are those on leishmaniasis (kala-azar and Oriental sore); for the author was one of those concerned with the initiation of a new line of research. The causal organism of this disease was discovered independently by Leishman and Donovan in 1903. Rogers, the following year, succeeded in cultivating the parasite, so demonstrating that during a part of its life history it became a motile flagellate known as a leptomonad or herpetomonad.

The problems concerned with the transmission of leishmaniasis have for years baffled all workers. Bed bugs, fleas, lice, mosquitoes, and other blood-sucking arthropoda have been studied, but no proof was forthcoming to show that any of these was responsible. A new line of investigation was opened up by Sinton in 1922, who noted that the distribution of a certain species of sand fly (*Phlebotomus argentipes*) corresponded geographically with kala-azar. Knowles, Napier, and Smith (1924) quickly demonstrated that laboratory-bred specimens of this fly could be readily infected with leptomonad flagellates when fed on cases of kala-azar. Christophers, Shortt, and Barraud confirmed this, and the Indian commission composed of Shortt, Barraud, and Craighead has definitely shown that the flagellates make their way forwards in *Phlebotomus argentipes* to the buccal cavity, pharynx, and biting parts. All attempts to infect man or a susceptible animal (the Chinese hamster) by the bites of experimentally infected sand flies have failed. Workers in China have confirmed the observations of those in India.

In Palestine, Adler and Theodor have infected *Phlebotomus papatasii* by feeding it on 'Oriental sore,' and here again the flagellates make their way forward to the proboscis of the fly. Experimental production of cutaneous leishmaniasis, however, has not been accomplished through the bite of infected flies, although the crushed-up contents of the gut inoculated into the skin of man produces a typical sore.

These researches indicate that certain species of sand flies act as the vectors of visceral and cutaneous leishmaniasis, but that some unknown factors involved in the transmission of both diseases to man require further investigation.

(2) *Pari passu* with observations on the pathogenic parasites and the biology of their vectors, great progress has been accomplished in chemo-therapy. Sir Leonard Rogers has compiled a most valuable short book on "Recent Advances in Tropical Medicine." Here he gives a lucid account of the remarkable advances in the treatment of diseases by drugs. The use of sodium or potassium antimony tartrate, for example, in the treatment of kala-azar, Oriental sore, and schistosomiasis is a triumph of modern therapy. The introduction of 'Bayer 205' and tryparsamide for the cure of African sleeping sickness, and emetine in the treatment of amœbic dysentery and liver abscess, has added potent preparations to the pharmacopœia.

Rogers has demonstrated the value of hypertonic alkaline injections in the treatment of cholera, and also has reported most interesting results in cases of leprosy which have been treated with injections of chaulmoogra oil and its derivatives. His results far surpass those given by any other treatment of this most dreaded of diseases.

In conclusion, attention must be directed to some very important researches recently made on yellow fever. In 1901, Reed, Carrol, and Agramonte proved that the vector was *Aëdes argenteus* (*Stegomya fasciata*). The organism remained unknown, but interest was revived in it in 1919 by Noguchi, who announced that the causal organism was a spirochæte (*Leptospira icteroides*). Other workers failed to confirm Noguchi, and a commission of the Rockefeller foundation continued researches in West Africa. Stokes, Noguchi, and Young lost their lives during these investigations, and recently the whole evidence points to the fact that the causal organism is a filterable virus. Great credit is due to Dr. Sellards, of Harvard University, who brought to England in 1928 the frozen virus from Dakar which enabled researches to be continued in this country. Hindle, by applying the technique successfully used by Laidlaw and Dunkin in the protection of dogs against dog distemper, has prepared vaccines from the liver of yellow-fever monkeys which absolutely protect monkeys against large doses of the virus. Aragão (1928) has proved the viruses of America and the west coast of Africa to be identical, and, further, has used the protective vaccine with apparently good results in a small epidemic in Brazil. About three or four hundred people were vaccinated, and none of those so treated caught yellow fever. Evidence points to the important fact that by the use of vaccine the population can be protected absolutely from the ravages of an epidemic of yellow fever.

J. G. THOMSON.

Historical Aspects of Science.

The Bases of Modern Science. By J. W. N. Sullivan. Pp. x + 246. (London: Ernest Benn, Ltd., 1928.) 12*s.* 6*d.* net.

IT is, perhaps, not unnatural at a time when science is developing at an unprecedented and somewhat embarrassing rate that the study of the history and philosophy of science should have fallen into neglect. When the newspaper is so interesting, it is not surprising that the historical treatise meets with less than its due share of attention. It is unfortunately true that very few of our physics students of to-day have any clear conception of the way in which their subject has been developed, and this neglect of the historical or, as some prefer to term it, the humanistic aspect of science is a weakness in science teaching which is being more and more generally recognised. One of the difficulties in introducing this desirable element into our studies has undoubtedly been the absence of suitable books. It is true that a few men of science have achieved the distinction of a biography, but it is the history of science rather than the lives of men of science with which we wish to concern ourselves; it is the development of ideas, and not of men, which is our proper study; and of such histories there are very few in the English language.

It is from this aspect that we welcome this very able and interesting volume from the pen of Mr. J. W. N. Sullivan. The title, "The Bases of Modern Science," is perhaps a little misleading. The book deals only with physical science, and there are others (a fact which physicists are perhaps a little prone to forget), and only about half of the book deals directly with what we call modern science. What Mr. Sullivan has done, and done

well, is to give us, without bewildering and unnecessary detail, and without the intrusion of ugly mathematical formulæ, a history of the growth and development of physical science from the time of Copernicus to the present day. He has traced in a simple but adequate way the rise, decline, and fall of the different conceptions which have dominated physics in that interval, and has attempted to make clear the often unspoken ideas and aims in the minds of those who formulated them.

Mr. Sullivan has selected the material for his purpose well, and has marshalled it with skill. Though the book is short in comparison with the vastness of its subject matter, the treatment is by no means superficial, and though it cannot be called light reading, it holds the attention and the imagination from beginning to end. It is not likely that the more advanced physicist will find himself in agreement with all that the author puts forward. There is apt to be more disagreement on the bases and aims of science than on its methods and results. Some of the disagreement will be more verbal than real. Mr. Sullivan, for example, uses the term 'mathematical' in a much broader sense than that to which we are accustomed, so broad, indeed, that it allows him to describe Faraday as "a mathematical genius." It is presumably in this wider sense that we must understand the word when he insists, as his main contention, that the aim of science is a mathematical description of the real world. It is, however, immaterial whether we agree with the author or not. He has written a book which will widen the outlook and deepen the interest of the new generation of science students, and one which they should certainly be advised to read.

It is only fair, in conclusion, to record that the author describes his book as "an attempt to expound the main ideas of physical science in non-technical language," and that it is intended for "intelligent readers who have had no scientific training." It is difficult to judge how closely such a reader will be able to follow Mr. Sullivan's argument. The language does not appear to be particularly different from that which a physicist would use in addressing fellow physicists, if he were fortunate enough to command Mr. Sullivan's mastery of style. Explanations are, however, given of the more unusual terms, and the non-scientific reader who is interested in scientific thought might be very well advised to attempt this book. He may not find it easy, but it is unlikely that he will be able to acquire any real understanding of the matter on easier terms.

J. A. C.

Our Bookshelf.

Organic Chemistry: a Brief Introductory Course. By Prof. James Bryant Conant. Pp. x+291. (New York: The Macmillan Co., 1928.) 10*s.* 6*d.*

IN his preface the author states that he wishes to find a stimulating approach to organic chemistry, and so has deliberately departed from the usual arrangement found in most organic text-books of dealing first with methods of purification and analysis, and then with the paraffins, etc.; in fact, he has definitely omitted all practical details throughout the book, leaving these to be dealt with in a practical course. The alcohols are chosen as a starting-point, in view of their relationship to water, and from these there is a natural development of derived compounds.

The author has certainly succeeded in giving a really readable exposition of organic chemistry. The book is not a mere collection of facts and formulæ, but follows in a natural sequence from one compound to another, and though, as would be expected, it is by no means complete, it gives the main facts about the simpler compounds of each series.

Moreover, the author has brought his facts up-to-date. Thus the preparation of methyl alcohol from water-gas is fairly fully described, as is the use of butyl alcohol and its derivatives in the new nitro-cellulose lacquers, whilst the cracking of petroleums and the use of ethylene from natural gas for the preparation of ethylene glycol are mentioned. The only points noted to be incorrect are the statements that "gun-cotton is a completely nitrated cellulose" and that "smokeless powder is made by treating gun-cotton with alcohol and ether." Otherwise the author has been successful in the difficult task of writing an interesting and at the same time accurate introduction to organic chemistry.

J. R. H. W.

Graphische Darstellung der Spektren von Atomen und Ionen mit ein, zwei und drei Valenzelektronen. Von Prof. Dr. W. Grotrian. (Struktur der Materie in Einzeldarstellungen, herausgegeben von M. Born und J. Franck, Band 7.) Teil 1. Pp. xiii+245. Teil 2. Pp. x+168. (Berlin: Julius Springer, 1928.) 34 gold marks.

THIS is a really admirable companion volume to tables of the simpler spectra such as A. Fowler's or Paschen and Götze's. It may be said to cover the same ground as Fowler's book, for it deals only with the simpler spectra which exhibit singlet, doublet, or triplet terms, and not spectra of higher multiplicities, but it deals of course with many more examples of such spectra taken from other atoms in higher stages of ionisation. It deals with them, too, in the light of the general systematisation of spectra which we now possess, which allows of a confident handling of the material at every stage.

The book deliberately sets out to exhibit graphically the structure of the spectra in all their details, so far as this is possible. The resulting 163 figures are published in a volume separate from the text, and for many purposes they will be found quite

admirable. It is obvious that a working spectroscopist will require tables of wave-lengths, wave numbers, and terms as well as the best diagrams, and it is much to be hoped that this book will stimulate new editions of the classical tables we have mentioned, extended to cover the same material as Prof. Grotrian's diagrams. The text gives an excellent description of the simpler atomic spectra, their nature, origin, and analysis, in complete detail. There is an especially admirable account of the finer details of the spectra of hydrogen and helium.

R. H. F.

The American Annual of Photography, 1929. Vol. 43. Edited by Frank R. Fraprie and E. J. Wall. Pp. 240 + Adv. 68. (Boston: American Photographic Publishing Co.; London: Sands, Hunter and Co., Ltd., 1928.) 7*s*. 6*d*.

THIS long-established annual is no longer just another of the same sort, although it includes a hundred or more pictorial illustrations and about twenty articles on various subjects by about as many different authors. The pictures include a great variety of types of subjects, some excellent portraits and views, and a few that we can only refer to as grotesque. Similarly, the articles range from the severely technical to the highly popular. One of the special features is "Who's Who in Pictorial Photography, 1927–8." This is a list of the contributors to fifty exhibitions practically all over the world, with the number of exhibitions that each has contributed to and his total number of prints hung. It includes similar lists for the two preceding years. As each person's address is given, this unique feature will doubtless be useful to many.

Among the articles that call for special notice is Mr. E. J. Wall's "Practical Digest of the Year's Work in Photography." His recent death reminds us that this is the last time that we shall have the advantage of Mr. Wall's wide knowledge and his ability to set forth the essence of the facts in an interesting and readable form. There is also from his pen an article on the very early history of the daguerreotype process, "prompted by the discovery of an early pamphlet while the library of American Photography was being catalogued." This appears to settle some matters as to priority, etc., that have been in dispute for many years.

The British Journal Photographic Almanac and Photographer's Daily Companion, with which is incorporated The Year Book of Photography and Amateurs' Guide and The Photographic Annual, 1929. Edited by George E. Brown. Pp. 800 + 63 plates. (London: Henry Greenwood and Co., Ltd., 1929.) 2*s*. net.

THE general appearance and arrangement of this annual are well known. Though not equal in size to the pre-War volumes, it is getting on in that direction. The pictorial section, introduced a year or two ago, is growing, and the photogravure reproductions are of the usual high quality. In turning over the pages there are two matters that force themselves upon one's attention in connexion with the progress of photography: First, the large number of firms that make apparatus for general kinematography, cameras, projectors, and supplementary items, and the large range of prices charged for them, from £5 up to £250; secondly, that although plates and films are more sensitive than ever before, lenses are being made with larger and still larger apertures, even up to $f/1\cdot5$. The trend, therefore, continues to be in the direction of shorter exposures, and the results that were surprising a few years ago have become commonplace.

The contribution of the editor is on photography in connexion with crime and the criminal, and is illustrated with several interesting examples, many of which are of foreign origin. The technical and historical details are arranged in the same way as heretofore, and include a list of tables in past "Almanacs" that are not included in the present volume, with the dates when they last appeared.

Soviet Union Year-Book, 1928. Compiled and edited by A. A. Santalov and Dr. Louis Segal. Pp. xxxi + 587. (London: George Allen and Unwin, Ltd., 1928.) 7*s*. 6*d*. net.

THIS year-book, now in its fourth year of publication, is much enlarged, though planned on the same lines as previously. It opens with the constitution and foreign relations, and gives in full various decrees of the Soviet government. The greater part of the book is devoted to the agriculture, mineral resources, foreign trade, and finance of the Union. The section on foreign trade has been much expanded and now gives full details of imports from and exports to various countries. These figures should prove useful, since they are not easily obtainable elsewhere. Under the heading of education it is noted that the Soviet Union claims to have 6122 technical schools, 124 universities, and 109 workers' faculties. There is also a long list of scientific institutes, the function of which is to assist in the industrial development of the country. Two maps show mineral resources, and two others show the political divisions of the Union. The list of books is almost entirely confined to publications in Russian.

Some Fundamental Problems of Cellular Physiology. By W. J. V. Osterhout. (The Third William Thompson Sedgwick Memorial Lecture. Published under the Auspices of the Yale School of Medicine on the Foundation established in Memory of Dr. William Chauncey Williams, of the Class of 1822, Yale Medical School, and of Dr. William Cook Williams, of the Class of 1850, Yale Medical School.) Pp. vi + 55. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1927.) 4*s*. 6*d*. net.

IN this Sedgwick memorial lecture the author deals with the mechanism of certain fundamental activities of the cell, especially those depending upon the existence of semi-permeable surfaces in the living state.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Knock Ratings of Pure Hydrocarbons.

IT is well known that different hydrocarbons, when used as fuels for internal combustion engines, possess different tendencies to detonate or knock, and one of the factors which decides the amount of knocking occurring is the chemical composition of the hydrocarbon used. In the course of a research on the chemical analyses of gasolines and hydrocarbon mixtures generally, we have prepared pure samples of various hydrocarbons in fairly large quantities, being of the opinion that trustworthy methods of analysis can only be evolved by this method. These hydrocarbons have recently been examined, through the kindness of the Anglo-American Oil Company, in an internal combustion engine, with the view of determining their knock ratings, this being done in an attempt to correlate chemical properties with engine performances.

At the present time it is the commonly accepted idea that, of the four typical hydrocarbon groups, the aromatics possess the best anti-knock values and paraffins the worst, olefines and naphthenes possessing intermediate figures of merit. Some time ago Egloff and Morrell (*J.I.E.C.*, **18**, 354; 1926), using data obtained by Ricardo (Empire Motor Fuels Committee Report, 1924), described a method for the chemical analysis of gasolines which they claim is capable of indicating comparative anti-knock values. In this they assume, so far as anti-knock properties are concerned, that 5 per cent of unsaturateds or 4 per cent of naphthenes is equivalent to 1 per cent of toluene; the paraffins being considered as knock inducers.

Egloff and Morrell have themselves pointed out the discrepancies of such a generalisation, and only advise this analytical method for the determination of knock ratings in the case of those fuels which have been shown by analysis and motor tests to give check results (*Oil and Gas Journal*, Jan. 27, 1927). More recently, Edgar (*J.I.E.C.*, **19**, 145; 1927) has demonstrated that all paraffins must not be classed as knock inducers, for 2.4.4 trimethyl pentane, first described by him, has anti-knock properties equivalent to benzol (see also Boyd, *Oil and Gas Journal*, Jan. 27, 1927).

Egloff and Morrell perforce based their method upon the only data at that time available, and seeing that Ricardo found it impracticable to use chemically pure hydrocarbons, it is imperative that the factors chosen for converting the different series into aromatic equivalents should afterwards be criticised. Stevens and Marley (*J.I.E.C.*, **19**, 228; 1927), working on the same subject, used pure samples of heptane, methyl cyclohexane, hexylene, and toluene as representatives of the four typical hydrocarbon groups, and showed that under their experimental conditions, 1 per cent of toluene was equivalent to 2 per cent of either hexylene or methyl cyclohexane in its ability to suppress detonation. It will be seen that these figures are not in agreement with those of Egloff and Morrell and Ricardo.

Apparently, the failure of chemical analyses to give correlation with engine performances is due to the fact that the various members of one certain general hydrocarbon class, for example, olefines or aromatics, do not possess the same knock ratings. For example, toluene is slightly better than benzene, whereas pseudo-cumene has pro-knock tendencies (*Aeronautical Res. Comm. Rep.*, No. 1013, 1925); normal heptane is a very bad detonator, while Edgar's octane is a valuable anti-knock.

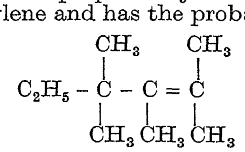
While studying the unsaturateds present in motor fuels, we have observed that the various members of this general class differ widely in their reactivities towards oxidising agents, and this gave us the idea that these hydrocarbons would possess widely different anti-knock values; this has been shown to be the case. These unsaturated hydrocarbons were each separately dissolved in a highly paraffinoid spirit (sp.g. 0·7334 at 15° C., 72·7 per cent paraffins) which possessed exceptional tendency to knock. The resulting blends were then matched with tetra-ethyl lead dissolved in the same spirit. The engine used was fitted with the Boyd and Midgley bouncing pin apparatus for the determination of knocking, and was run at a constant speed of 500 rev. per minute throughout the tests. A 20 per cent concentration of unsaturated hydrocarbon was maintained in each of the synthetic mixtures made.

The following results were obtained:

20	per cent	Cyclohexane	= 1·0	c.c.	ethyl fluid per gallon.
20	,,	Benzene	= 2·1	c.c.	
20	,,	Cyclohexene	= 2·4	c.c.	,, ,,
20	,,	Toluene	= 2·75	c.c.	,, ,
20	,,	Pentene-2	= 3·5	c.c.	,, ,,
20	,,	Trimethyl ethylene	= 4·5	c.c.	,, ,,
20	,,	Diamylene	= 6·0	c.c.	,, ,,
20	,,	Diisobutylene	= 6·6	c.c.	,, ,,

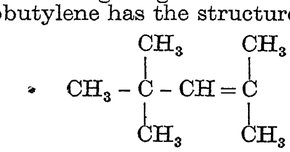
Owing to the difficulty of obtaining a sufficient amount of these hydrocarbons, it was not found possible to use synthetic mixtures containing a greater concentration than 20 per cent of the above substances.

The diamylene was prepared by the polymerisation of trimethyl ethylene and has the probable structure:



(Joubert and Norris, *J.A.C.S.*, **49**, 873; 1927). As used, it had a boiling range of 150°-156° C.

The diisobutylene has the structure:



(Butleroff, *Chem. Centralbl.*, **2**; 1877; Kondakow, *J. Prakt. Chem.*, **59**, 287; 1899), and is the olefine corresponding to Edgar's octane.

The above results show that cyclohexene has anti-knock properties equivalent to benzene, while the others are far more effective than benzene, especially diamylene and diisobutylene, which at a concentration of 20 per cent are found to be equivalent to 37·5 per cent and 40 per cent benzol respectively. Tested on the same scale, 20 per cent of toluene was found to be equivalent to 22·5 per cent of benzol. Thus it will be seen that aromatic hydrocarbons have lower knock ratings than the above unsaturateds.

Diisobutylene and diamylene offer certain advantages as anti-knock dopes over benzol. Benzol has a freezing-point too high (−14° C.) for aviation purposes when used in an undiluted state, and a 50/50 petrol-benzol mixture freezes at about −20° C.; consequently, 60 per cent of benzol is about the greatest concentration permissible. This limits the Highest Useful Compression Ratio (H.U.C.R.) of an

aero-engine to below 7 : 1 ; hence there is a distinct loss of possible efficiency. Diisobutylene or diamylene, having better anti-knock properties than benzol, could permit of a higher H.U.C.R., and, moreover, blends of these hydrocarbons would not be liable to freeze at high altitudes, both substances being liquid at − 45° C. in an undiluted state. Diisobutylene may be conveniently prepared by the polymerisation of the isobutylene content of 'cracked' gases by means of sulphuric acid, while diamylene may be obtained by the similar treatment of either trimethyl ethylene or tertiary amyl alcohol.

Since this work was completed it has been found that E.P. 253,131 covers the use of these two olefines, among others, as anti-knock dopes, and describes them as being better than benzol for this purpose, but no comparative figures are quoted.

It is interesting to note that of the olefines we have tested, those which are the more stable towards bromine, sulphuric acid, potassium permanganate, and potassium bichromate, are the more effective in suppressing knocking.

A. W. NASH.
DONALD A. HOWES.
Department of Oil Engineering and Refining,
University of Birmingham.

A Permeability Test with Radioactive Indicators.

CERTAIN investigators (see, for example, W. J. V. Osterhout, "Some Fundamental Problems in Cellular Physiology," 1927 ; especially pages 36-48) believe that the protoplasm of the living cell is permeable only to undissociated molecules but impermeable to ions.

It seemed possible to me to test this theory with the method of radioactive indicators [1] (Hevesy-Paneth). The advantage of this method is that only very small amounts of the ions which enter the cell are necessary and that a very small concentration can be detected. Radioactive lead (thorium-B) was used as an indicator for lead ions, and therefore lead nitrate was dissolved in sea water so as to make it 10^{-5}–10^{-6} M in respect to lead ions. Cells of *Valonia macrophysa* were used since the large volume and the amount of sap available make the investigation easier, and since investigations of the permeability of this cell were carried out by Osterhout and his collaborators.

To test whether or not the presence of lead causes any injury to the cell, the cells were placed in sea water with different amounts of lead nitrate added, and for several months the behaviour of the cells observed. The cells did not change in colour or rigidity, and were, according to Dr. L. R. Blinks, who kept them in the same laboratory with other cells, in a normal state, judged from macroscopic appearance.

For the permeability experiments, the cells were placed in sea water containing a known amount of lead nitrate and thorium-B. After 20 or 30 hours the cells were taken out, washed off with inactive sea water, and dried on blotting paper. The sap was removed, a certain amount (0·2–0·3 c.c.) evaporated in a watch glass, and the radioactivity measured in an α-ray electroscope. The activity of the same amount of the original solution and of the sea water in which the cells were kept was measured. In this way we ascertained how much lead is absorbed by the cell wall and how much enters the vacuole. In all experiments (14 cells) it was found that about 50 per cent of the lead ions present in the original solutions are absorbed by the cell wall, but that practically no lead enters the vacuole.[2] The same experiments were carried out with cells which had been kept in sea water plus lead nitrate for four months. Also in this case no lead could be found in the vacuole.

One may conclude that all the lead which disappears from the sea water is adsorbed by the cell wall or the protoplasm forming an insoluble compound which cannot enter the vacuole. In this case one would expect that in dead cells also the lead would be fixed at the cell walls and therefore cannot be found in the sap. Experiments with three dead cells have shown that lead does enter a dead cell. It is apparently fixed there to small particles of organic matter which are to be found always in dead cells. Therefore it cannot diffuse back into the surrounding sea water and *an apparent concentration* of lead in the dead cells takes place.

It was interesting to see whether radium emanation, being a rare gas, would enter the cells, as one would expect from the theory. Small capillaries (16 mm. long), filled with radium emanation (about 0·01 m.c.), were broken under the sea water containing the cells to be tested. It was found that already after one hour the sap is approximately as active as the surrounding sea water (15 cells were investigated).

After every experiment, Dr. L. R. Blinks examined the macroscopic appearance of the cells and tested the sap for sulphate ions. (The presence of sulphate ions would indicate a severe injury.) Part of the sap in our lead experiments and the sap of every single cell in the experiments with radium emanation was tested in this way. Injury was found in one cell out of a total of three, exposed for 20 hours in radium emanation, and traces of sulphate ions in two cases out of twelve, after 1 to 2 hours exposure in radium emanation. One cell that had been in lead nitrate for four months was soft, but did not give any sulphate reaction and did not show any sign of injury in our test.

Summary.—Using radioactive indicators for testing the permeability of single cells of *Valonia macrophysa*, it was found that lead ions do not enter the sap of the living cell even if the cells are kept for several months in lead nitrate solution. Lead ions enter readily the sap of dead cells. Radium emanation, being a rare gas, is already after one hour distributed evenly between the cell sap of living cells and the surrounding sea water.

This investigation was carried out in the spring of 1927 during our stay at the Rockefeller Institute for Medical Research, New York City, and we are indebted to the International Education Board who made our stay at the Rockefeller Institute possible.

KARL LARK-HOROVITZ.
Physics Department,
Purdue University,
Indiana.

[1] That is, to determine the amount of ions present, of a certain kind, by the determination of the radioactive isotope mixed with them. Since a chemical separation of isotopes is impossible, the change in activity of the radioactive isotopes is the indicator for changes in the concentration of the inactive ion.

[2] A trace of activity which was found twice immediately after drying is due to traces of thorium-C. This may have entered the cell in ionic form, but since thorium-C is present only in an extremely small concentration, this is not contradictory to any other experiment on permeability. Such a small amount may possibly also enter in other cases, but could not be detected. On the other hand, thorium-C shows in neutral solutions a quasi-colloidal behaviour and may have entered the cell in form of an undissociated complex.

Molecular Constants of Hydrogen.

ONE of us recently published a table of constants for the neutral hydrogen molecule (*Proc. Nat. Acad. Sci.*, **14**, 12 ; 1928). The most uncertain quantity in that table was the value of the moment of inertia for the 'B' level. The value given ($1{\cdot}99 \times 10^{-40}$) is based on Hori's very doubtful interpretation of Witmer's band progression B_3-A_n. We have now photographed the entire B-A system in the second order of a ten-foot vacuum spectrograph, designed by Prof. J. J. Hopfield

and constructed in the shop of this laboratory. The new plates show clearly that the bands of the B-A system, originally analysed by Dieke and Hopfield, consist of R and P branches only, in contrast to Hori's assumption of an R branch plus coincident P and Q branches. On this new interpretation a complete verification of the combination principle has been obtained. The lines show clearly the alternating intensity to be expected for a symmetrical molecule.

While this work was in progress there appeared an article by Kemble and Guillemin (*Proc. Nat. Acad. Sci.*, **14**, 782; 1928), in which they conclude, on theoretical grounds, that the B-A bands must consist of R and P branches only. Using the published data of Dieke and Hopfield (*Phys. Rev.*, **30**, 400; 1927) and of Witmer (*Phys. Rev.*, **28**, 1223; 1926), they then calculated, on this interpretation, a moment of inertia for the B level of $1\cdot51 \times 10^{-40}$. Because of the incompleteness and relative inaccuracy of the data, no great accuracy is to be expected for this value.

Our own data are far more complete and accurate, the lines having been measured directly against first order iron standards. The spacing of the rotational levels (values of ΔF) for the band progression B_0-A_n fulfils accurately the expected relations between the vibrational and rotational energy constants. Hence it is possible to obtain a very trustworthy value of the moment of inertia. Using the best analytic method now known, we obtain on the basis of the old quantum mechanics, for the zero vibrational level of the B state, $B_0 = 19\cdot46 \pm 0\cdot04$, giving with the usual constants, $I_0 = (1\cdot423 \pm 0\cdot003) \times 10^{-40}$ gm.cm.^{2}. The rotational energy is given by $B_0hm^2 + D_0hm^4 + \ldots$, with m a half-integer to within about 0·005. In obtaining the calculated value of $D_0(= -4B_0{}^3/\omega_0{}^2)$ we used $\omega_0 = 1330$ cm.$^{-1}$, derived by us from the recent accurate data of Richardson and Davidson (NATURE, **121**, 1018; 1928), in place of the value 1325 given in the table previously mentioned. Analysis of the higher vibrational levels of the B state is in progress.

H. H. HYMAN.
R. T. BIRGE.

University of California,
Jan. 1.

Homing of an Owl.

THE following authentic case of the homing of an owl is of general interest in connexion with the fascinating, but often very baffling, problem of how animals find their way about.

A pair of Cape barn owls (*Strix flammea maculata* Brehm.) had taken up their abode in the roof of the verandah of the homestead of Mr. F. C. Pope-Ellis in Natal (Ashburton, altitude 2302 ft.), and one of the fledglings was reared by hand. One of the wings was afterwards partially clipped, and this prevented any great power of flight. The bird was free, but was quite tame; it was fed regularly by hand and never appeared to go far from the homestead. With the clipped wing the bird was unable to fly more than about fifty yards without alighting, and it was never seen to fly to any appreciable height in the air. It retired at will to a sheltering box provided for it.

At the age of seven months the owl was taken (Dec. 3, 1928, at 9 A.M.) in a closed box by motor-car to another farmstead (Cotswold, altitude 4807 ft.) which is distant about sixty miles from the first-mentioned farm. In its new quarters the bird remained for four days and then disappeared. Eight days later, at 6 A.M., it was found in its shelter at its original home and in a perfectly placid condition.

Thus in eight days the young bird, with weak powers of flight owing to its cut wing, travelled sixty miles over hilly and much broken country, including both bush and veld. How did the bird find its way back?

We cannot invoke racial memory as in the case of a fixed annual migration to a distant land. Apparently the only other alternatives are: (1) that in its original home the bird had acquired a general knowledge of the major distant features of the landscape and was led back by such clues, or (2) that it was conducted back by certain orientating influences, the nature of which we can only dimly surmise.

The tendency at the present time is to deny the existence of these obscure directing influences in the homing of animals; and in the case of pigeons, bees, etc., it seems to be experimentally proved that the ability to return depends mainly on the recognition of clues in the surroundings which show the way home.

The existence of recondite influences which are capable of directing movement is, however, evidenced by the assembling of male moths around the female, and it is extremely probable that the meeting of the sexes in many animals is largely affected by analogous influences.

ERNEST WARREN.

Natal Museum,
Pietermaritzburg.

Anomalous Magnetic Rotation of Excited Neon.

IN a paper on the anomalous magnetic rotation in excited neon (*Phys. Rev.*, **32**, 681; 1928), I published values of the dispersion constants determined from the anomalous rotation which were erroneous. Due to the omission of the factor $\pi/180$ from the numerical part of equ. (4) of that paper, the values of the dispersion constants given are much larger than they should be. If this factor is included, the values so found are considerably smaller than those of Kopferman and Ladenburg, instead of much larger. This result is also more in accordance with what one might expect from their work on the effect of the different conditions of excitation on the anomalous dispersion. The pressure in the tube and the exciting current used by me were both such as to give results considerably below the maximum, whereas the values of Kopferman and Ladenburg are saturation values.

The corrected values for each wave-length are given below in the second column, in comparison with those of Kopferman and Ladenburg in the third column.

6266	$0\cdot55 \times 10^{11}$	$2\cdot15 \times 10^{11}$
6532	0·34	1·36
6163	0·31	1·32
6506	$0\cdot75 \times 10^{11}$	$3\cdot38 \times 10^{11}$
6382	0·60	2·45
6096	0·44	2·15
6074	0·29	1·40
6304	0·22	0·9
6029	0·24	~0·6
6402	$3\cdot06 \times 10^{11}$	$7\cdot25 \times 10^{11}$
6143	1·14	2·16
6334	0·97	3·26
5944	0·58	1·59
6217	0·34	0·9
5881	0·35	1·0
5975	0·28	~0·5

R. N. JONES.

Drexel Institute,
Philadelphia, U.S.A.

The Raman Effect with Hydrochloric Acid Gas: the 'Missing Line.'

I have obtained lines of modified wave-length by the excitation of hydrochloric acid gas at atmospheric pressure, by the light of a glass Cooper-Hewitt lamp about five feet in length, placed parallel to and in contact with the tube containing the HCl, the whole being completely surrounded by a cylindrical reflector of very highly polished aluminium, which was in contact with the two glass tubes. Under these conditions the temperature of the gas was about 100° C., as indicated by a thermometer introduced into the metal cylinder.

With an exposure of only twenty-four hours, and a Hilger constant deviation spectroscope, I obtained a very sharp and distinct line nearly midway between the mercury lines 4358 and 4915. It was almost in coincidence with the argon line 4579 (used as a comparison spectrum). Considering this line as excited by the mercury line 4046, the frequency difference between the exciting line and the modified line ($\lambda = 4581$) corresponds to the frequency in the infrared which would represent a line at $3{\cdot}47\ \mu$, almost exactly the centre of the vibration rotation band. The line thus appears to be the so-called 'missing line,' corresponding to a vibration transition unaccompanied by change of rotation, which does not appear in the absorption spectrum of the gas.

The first photograph which I obtained showed a double line, namely, the 'missing line' and the first vibration-rotation line next to it. In this case the tubes were not completely surrounded by reflectors and the temperature was lower; the tube may also have contained some air and a trace of moisture. This point is under investigation. In my last photograph, I find also six lines immediately on the long wave-length side of 4358, but have not yet determined whether they represent a part of the infra-red band or are due to interference produced by the thin glass of the bulb. As they appear on one side only of 4358, I feel sure that they are real.

R. W. Wood.

Magnetic Properties in Relation to Chemical Constitution.

In the recent letter by Prof. Lowry and Mr. Gilbert (Nature, Jan. 19, p. 85) some interesting points are dealt with concerning the evidence afforded by magnetic data as to the chemical constitution of various compounds. The authors note that the fact that cupric sulphide, CuS, is diamagnetic suggests that this compound must be a cuprous compound with a double molecule rather than a cupric salt as previously supposed. They also mention that X-ray analysis has shown that iron pyrites must be a ferrous disulphide, $Fe^{++}\bar{S}\text{-}\bar{S}$.

Magnetic measurements can furnish further information as to the chemical constitution of the latter compound. The magnetic properties of the cubic crystals of the type represented by iron pyrites, FeS_2, cobaltite, CoAsS, etc., were recently investigated. The case of iron pyrites may be taken as typical. It was found that after allowing for the diamagnetic properties of the sulphur atoms, the iron atom possessed a small residual positive magnetic moment, and the susceptibility was independent of the temperature. These properties are in agreement with what would be expected for a twofold co-ordination compound of *ferrous* iron, but are quite different from those of simple ferrous salts. The Fe^{++} ion in iron pyrites must therefore have a constitution corresponding to that of the iron atom in, say, potassium ferrocyanide, and not to that of the iron atom in, say, ferrous sulphate.

We must therefore classify these minerals, of which iron pyrites is typical, as co-ordination compounds. Incidentally, their properties are in agreement with Cabrera's scheme for the relation between constitution and magnetic properties in co-ordination compounds, but the above conclusions are independent of the view taken as to the arrangement of the electrons in such compounds.

L. C. Jackson.

The University, Bristol.

Energies of Dissociation of Cadmium and Zinc Molecules.

The 2288 ($1^1S - 2^1P$) absorption line of cadmium broadens symmetrically with pressure until it reaches a sharp limit at the 2212 cadmium absorption band, but reaches no definite limit on the long wave-length side. In the electrodeless discharge in cadmium vapour, the 2288 line is surrounded by a continuous spectrum corresponding to the broad band found in absorption, but the limiting band at 2212 does not appear.

These facts can be correlated with a pair of potential energy curves for the cadmium molecule, and from these curves the energy of dissociation of Cd_2 can be found.

The limiting band at 2212 is correlated with the transition of an electron from the non-vibrating 'grund' state of Cd_2 to the 2^1P level of the cadmium atom; that is, to the limit of the vibrational levels of the excited molecule. The transition from the limit of the vibrational levels of the normal state to the limit of the vibrational levels of the excited molecule is an atomic transition which in the present case is $1^1S - 2^1P$ (λ2288). Therefore the difference in energy between the limiting band at 2212 and the atomic line at 2288 gives the energy of dissociation of the normal Cd_2 molecule. This equals 0·200 volt for Cd_2 and 0·246 volt for Zn_2.

The full report of this work, which was done in Palmer Laboratory, Princeton University, will appear in the *Philosophical Magazine*.

J. G. Winans (U.S. National Research Fellow).

University of Göttingen.

Piles of Pebbles on Beaches.

In a letter published in Nature of Dec. 1, a correspondent directs attention to the occurrence of regularly spaced groups of pebbles along a beach in the New Hebrides, separated by patches of sand devoid of pebbles. I may say that a similar occurrence is frequently to be observed on the beach in Bournemouth Bay to the west of Alum Chine, where the piles of stones collect at distances of from 15 to 25 yards between centres, to a height of one or two feet, and appear to contain all sizes indiscriminately between ¼ in. and 4 in. The regularity of the spacing along the water's edge can be well observed from the cliffs above.

The action of the tides and wind in this part is such as to cause frequent changes in the nature of the beach, both in position of normal high-water mark and in the *slope* of the beach, and the occurrence of the regular spacings is therefore apparently haphazard.

It might be suggested that when the slope of the beach bears a certain relation to the mean distance between waves, to the angle of incidence, and to the mean quantity of water in each wave, then the time of return of each exhausted wave may be in agreement with, or bear some integral relation to, the time interval between waves. It would then seem possible for a regular condition to arise which might cause the observed facts.

R. M. Clark.

Municipal College, Bournemouth.

Einstein's Field-Theory.[1]

By Prof. A. S. EDDINGTON, F.R.S.

THE new 'Unified Field-Theory' of Einstein is contained in two papers amounting altogether to eleven pages in the Berlin *Sitzungsberichte*, **17**, 1928, and **1**, 1929. There is an intermediate paper which does not concern us, since it follows a line of development now abandoned. For the present, at any rate, a non-mathematical explanation is out of the question, and in any case would miss the main purpose of the theory, which is to weld a number of laws into a mathematical expression of formal simplicity. We are chiefly interested in how it compares, both as to methods and results, with the existing field-theories which have had some measure of success.

Each attempt to unify gravitation and electromagnetism has been associated with what may be called an 'illustrative' geometry or world-geometry. A qualifying adjective is necessary, because I think it is now common ground that the actual geometry (obeyed by measured lengths, angles, etc.) is Riemannian. Einstein's world-geometry may be briefly described as a geometry in which there are *parallels* but not *parallelograms*. Thus he admits the existence, even at great distances, of a line CD equal and parallel to AB; but the line through B parallel to AC fails to cut CD. (We are dealing with at least three dimensions, so that lines are not necessarily coplanar.) The geometrical idea of an abortive parallelogram, which fails to close up at its fourth corner, does not carry us very far, and it is necessary to proceed analytically. The following is a modified and shortened version which, I think, is equivalent to the original analysis.

We take a general system of co-ordinates x_μ with a Riemannian metric given by $g_{\mu\nu}$, and also in each small region a local system of co-ordinates x'_a which are orthogonal and have a Euclidean metric so that $g'_{ab}=\delta_{ab}$. These systems are connected by vector transformation formulæ

$$dx_\mu = h_a{}^\mu dx'_a \qquad dx'_a = h_\mu{}^a dx_\mu. \qquad (1a, b)$$

The coefficients h are functions of the co-ordinates, and the symbol denotes a different (but related) set of functions according as the Greek or Latin suffix is uppermost. It is not supposed that (1b) is integrable, that is to say, the co-ordinates x'_a are not determinate, but only their differentials dx'_a. By the law of tensor transformation

$$g^{\mu\nu} = h_a{}^\mu h_b{}^\nu g'^{ab} = h_a{}^\mu h_b{}^\nu \delta^{ab} = h_a{}^\mu h_a{}^\nu. \qquad (2)$$

Also, if we displace a vector A'^a so that its components in local co-ordinates are constant, that is, if $\partial A'^a/\partial x_\sigma = 0$, we have

$$\frac{\partial A^\mu}{\partial x_\sigma} = \frac{\partial}{\partial x_\sigma}(h_a{}^\mu A'^a) = A'^a \frac{\partial h_a{}^\mu}{\partial x_\sigma} = A^\epsilon h_\epsilon{}^a \frac{\partial h_a{}^\mu}{\partial x_\sigma}$$

by using the transformation law of contravariant vectors (1). This result is written

$$\frac{\partial A^\mu}{\partial x_\sigma} + \Gamma^\mu_{\epsilon\sigma} A^\epsilon = 0, \qquad (3)$$

with $$\Gamma^\mu_{\epsilon\sigma} = -h_\epsilon{}^a(\partial h_a{}^\mu/\partial x_\sigma). \qquad (4)$$

As already stated, Einstein's geometry admits that up to any distance there can exist equal and parallel vectors, or (to use a less arbitrary description) vectors in one-to-one correspondence. The purpose of the local co-ordinates is to indicate this correspondence directly, the components A'^a of two such vectors having equal values. Equation (3) then indicates how to move a vector about in space without varying A'^a, and therefore remaining equal and parallel to itself. Einstein's geometry postulates that the parallelism is unique and independent of the route of transfer; accordingly (3) must be integrable.

The general idea is that the nature of the field can be completely described by specifying the values of the 16 quantities $h_a{}^\mu$ at every point. Such a description is more comprehensive than if the 10 quantities $g^{\mu\nu}$ required to define the gravitational field are specified, so that it is able to embrace the electromagnetic field in addition. The gravitational field is determined immediately from the h's by (2); they also furnish the quantities Γ by (4). Einstein sets $\Lambda^\mu_{\epsilon\sigma} = \Gamma^\mu_{\epsilon\sigma} - \Gamma^\mu_{\sigma\epsilon}$, and identifies the electromagnetic potentials with the four quantities $\Lambda^\sigma_{\epsilon\sigma}$.

We are now in a position to see the manner in which the present theory deviates from existing unified field-theories. I make the comparison with the affine field-theory which I gave in 1921;[2] it was used by Einstein in 1923 as the basis of one of his former researches on this problem. The affine theory also rests on equation (3), but does not limit Γ to the special form (4); on the other hand, it makes the limitation $\Gamma^\mu_{\epsilon\sigma} = \Gamma^\mu_{\sigma\epsilon}$, which is by no means implied by (4).

The complete contrast of the two theories which have equation (3) in common is rather remarkable:

(1) In Einstein's theory equation (3) is integrable; in the affine theory it is essential that it should be non-integrable.

(2) In the affine theory $\Gamma^\mu_{\epsilon\sigma} = \Gamma^\mu_{\sigma\epsilon}$; in Einstein's theory it is essential that they should be unequal.

(3) The curvature tensor $({}^*B^\epsilon_{\mu\nu\sigma})$ which provides all the gravitational and electrical field-variables on the affine theory, vanishes identically in Einstein's geometry; the expression $\Lambda^\mu_{\epsilon\sigma}$ which provides all the gravitational and electrical field-variables on Einstein's theory, vanishes identically in affine geometry.

It has of course been realised that an extension of affine geometry with non-vanishing $\Lambda^\mu_{\epsilon\sigma}$ is possible. This has been developed mathematically by Schouten and others, but no particular physical application has resulted. The fact is that such an

[1] "Zur einheitlichen Feldtheorie." Von A. Einstein. (Sonderabdruck aus den *Sitzungsberichten der Preussischen Akademie der Wissenschaften*, Phys.-Math. Klasse, 1929, 1.) Pp. 8. (Berlin: Walter de Gruyter und Co., 1929.) 1 gold mark.

[2] *Proc. Roy. Soc.*, **99**, p. 104. I have followed this theory in "The Nature of the Physical World," chap. vii. and xi.

extension provides far more mathematical variables than the physicist can utilise. Einstein's development is more promising, since he boldly accompanies this extension with a restriction ; and room is made for the new variables by sweeping away old ones. Moreover, he renders his restriction plausible by putting it in the form of a geometrical postulate of distant-parallelism.

It will thus be seen that Einstein makes a striking new departure ; the rest of the development may be briefly summarised. The condition for integrability of (3), namely, the vanishing of the curvature tensor, leads to two important identities satisfied by the $\Lambda^{\mu}_{\epsilon\sigma}$. This rather raises an expectation in the reader's mind that the field laws are about to appear as identities ; but this is not fulfilled. A field law of simple form is duly announced, looking indeed so much like one of the identities that it requires a careful inspection of the suffixes to see the distinction. Here I would venture on a criticism. Can any theory which requires field laws other than identities give real satisfaction ? To introduce a field law limiting the geometrical possibilities is a confession that the initial geometry was too wide. The ideal should surely be either to start with a geometry which precisely fits the phenomena so that it needs no supplementary field laws, or to start with the most unrestricted geometry and treat every limitation as a field law.

The consequences of the field law are worked out only to a first approximation, and therefore some of the questions we should wish to put remain unanswered. " A fuller investigation will have to show whether a Riemann-metric in conjunction with distant-parallelism actually gives an adequate conception of the physical qualities of space. According to this research it is not improbable."

In any comparison of these theories it should be borne in mind that what is being given is a graphical representation bound by no particular rules. To say that Einstein's or Weyl's or Eddington's illustrative geometry is the only right one would be like saying that a graph of a moving particle with time and space as co-ordinates is right but a graph with velocity and curvature as co-ordinates is wrong. World-geometry is very like other graphs ; if wisely chosen it may exhibit or suggest relationships, provide useful nomenclature, and generally assist the mind in orderly thought. More hazardously it may be supposed to shadow the structure of the substratum of physical phenomena. I do not think Einstein has this last aspect in mind, or he would have stressed the vanishing of the curvature tensor (which might be visualised as a structural attribute of the æther) rather than the formal property of distant parallelism. I take it that he commends his graph to our notice as a means of exhibiting in its simplest form the mutual interdependence of gravitational and electrical quantities. For my own part I cannot readily give up the affine picture, where gravitational and electrical quantities supplement one another as belonging respectively to the symmetrical and antisymmetrical features of world measurement ; it is difficult to imagine a neater kind of dovetailing. Perhaps one who believes that Weyl's theory and its affine generalisation afford considerable enlightenment, may be excused for doubting whether the new theory offers sufficient inducement to make an exchange.

Human Speech.[1]

By Sir RICHARD PAGET, Bart.

HUMAN speech—which is practised by all races of mankind—is a rough combination of two separate arts, namely, phonation, due to the reed-like action of the vocal cords, and articulation, due to the various movements of the jaw, lips, tongue, soft palate, epiglottis, and false vocal cords. Phonation is the language of the emotions, while articulation is the language of the mind—phonation being, as Darwin realised, the older art.

The mechanism of the vocal cords may be very simply imitated by cutting a longitudinal slit about 3 cm. long in an indiarubber tube of, say, 1 cm. internal diameter. If the tube be stopped at about 5 cm. from the slit, and air be blown in at the other end, the air passing through the slit may be set in vibration so as to produce a musical note. The conditions for this effect are most easily obtained by adjusting the resonance of the air inside the tube adjoining the slit—by varying the position of a constriction or partial stop applied between the slit and the air supply. At any position at which ' phonation ' occurs under normal conditions of the slit, a musical range of about six or seven semitones can be obtained by varying the tension of the slit portion of the tube, the note rising as the tube is stretched. As the resonating length is shortened (so as to raise the resonant pitch) the musical range is transposed to a higher key, the range of transposition in the present experiment being also about seven semitones.

It is suggested that the so-called ' registers ' of the human voice are due to a similar set of conditions, and that the changes of resonance are produced by variation of the size and shape of the cavity into which the vocal cords ' deliver,' namely, that made by the false vocal cords and other movable parts of the pharynx. At each setting of this cavity a new range of notes is then obtained, depending on the tension and thickness of the vocal cords.

The lips of a trumpeter behave in a very similar way, but the resonance changes, if any, must then be made (as in the rubber-tube model) in the passage behind the reed instead of in the cavity into which it delivers, as in the case of the vocal cords.

The lungs, besides functioning as bellows, are a very efficient sound absorber, the branching air

[1] Substance of two lectures delivered at the Royal Institution on Dec. 6 and 13, 1928.

passages and air cells acting like a shelving beach towards waves of the sea, to convert the sound waves that pass down the windpipe into heat.

In whispered speech we have articulation without phonation. Whispered speech, therefore, lacks the emotional range of voiced speech. All the English speech sounds can be rendered in a whisper, and it appears that the real distinction between the so-called voiced and unvoiced consonants, such as *b* and *p*, *v* and *f*, *dh* and *th*, *z* and *s*, etc., is due to the action of the false vocal cords.

The action may be illustrated by a model in which the vocal cords are shaped in plasticene, as if in an open (whispering) position, and deliver their air jet into a rubber tube 2·5 cm. in diameter, which acts as the pharynx of a vowel-sounding tube. If, while air is supplied to the model, its mouth is alternately obstructed and released by hand, a whispered *p* is heard when the pharynx tube is uncompressed, but the sound is changed to a whispered *b* if the pharynx tube is compressed so as to form a constriction at 2 to 3 cm. in front of the fixed vocal cords. These conclusions have been confirmed by direct observations made in America by Prof. Oscar Russell, of Ohio University.

Another recently observed action of the pharynx is its production of the high-pitched resonances—of the order of 2500-3000 ∼—which I have observed by ear in the case of certain of my own vowel sounds, and which have also been disclosed by instrumental methods at the Bell Telephone Laboratory in New York. That these resonances (in my own case) are pharyngeal, is shown by the fact that they can be lowered in pitch by five or six semitones by external (transverse) pressure on the throat immediately above 'Adam's apple.' They cannot be consciously varied without external aid. It is evident that the pharynx plays a very large part in the process of articulation in modern speech.

Originally, it is suggested, articulation was evolved as a specialised form of pantomimic body gesture, by which primitive man, like his animal relations, was accustomed to explain himself to his fellows Darwin, in "The Expression of the Emotions," pointed out that there is, in man, a natural sympathy of movement between the human jaw and tongue and the human hand, so that children learning to write are seen to twist about their tongues as their fingers move 'in a ridiculous fashion.' As primitive man pantomimed with his hands and body generally, his tongue took part in the game without his being aware of the fact, and thus it developed a pantomimic technique of its own. When the pantomimist wished to direct attention to his actions, he made grunting or blowing noises, and the (unconscious) movements of his tongue then modified the air flow and the acoustic resonances of the vocal cavities through which the air passed. In this way the bodily pantomimic code became associated with an acoustic code, which developed into speech.

The various tongue gestures were necessarily simpler and fewer in number than the corresponding hand gestures, since (as would be found by experience) lateral movements of tongue, lips, and jaw do not appreciably alter the vocal resonances. The movements of articulation are therefore practically limited to two dimensions, whereas the hand and body gestures work in three. It follows that in human speech a particular gesture of articulation may represent several originally different body gestures—in other words, that speech was always more ambiguous than the pantomimic sign-language.

The original pantomime and speech of primitive man may be conceived as analogous to the bodily pantomime which is naturally developed by deaf-mutes, and by which a deaf-mute of one country can without difficulty make himself understood by one of another country, of whose written and spoken language he is wholly ignorant. Just as various communities of deaf-mutes naturally evolve new signs and conventions of their own—which other deaf-mutes cannot understand until they have especially learnt them—so the tribes of primitive men may be imagined to have evolved local words, idioms, and conventions from which the various language groups of the world were developed.

The theory that speech is due to mouth pantomime was, I believe, first enunciated by Dr. J. Rae, of Honolulu, in *The Polynesian* newspaper for 1862, but Socrates, according to Plato in the Cratylus, came very near the same idea; Dr. A. R. Wallace, writing in 1895 in *The Fortnightly Review* (No. 64), also put forward the theory that mouth pantomime constituted a "fundamental principle which has always been at work, both in the origin and in the successive modifications of human speech."

The evidence which has now been accumulated seems to justify a more serious consideration than has yet been given to the theory. Thus it appears, on experimental grounds, that in listening to speech our ears are not primarily interested in the sounds themselves, but rather in the evidence which the sounds afford as to the postures or gestures of the tongue and other organs of articulation. The facility with which the deaf may be taught to understand speech by 'lip-reading,' in spite of the very limited information which sight alone can afford as to the movements going on inside the mouth and throat, points in the same direction. Children, when inventing words of their own, very commonly employ a form of mouth pantomime—thus, of 18 such words mentioned by Prof. O. Jespersen at p. 152 of his book on "Language," 12 appear to be pantomimic: for example, ˑfuˑwɛ = soap—a gesture of blowing away soapsuds; dɛˑdɛtsh = horse—a galloping gesture made with the tongue.

Grown-up people occasionally do the same—as witness the invention of the word 'blimp' to denote the small podgy dirigible balloons which were developed during the War. The word is produced by a small-mouth gesture (producing the sound *bĭ*) followed by the 'podgy' gesture *mp*, with an intermediate upward flick of the tongue, *l* (as if to suggest an attachment to the middle of the 'bimp'), which completes the word—'blimp.'

Arguments of this kind seem at first sight fantastic, but it must be remembered that in the

evolution of speech we are dealing with a product of man's subconscious mind—" such stuff as dreams are made of "—and that it is no more strange that our speech symbolism should be fanciful than that our dreams should be so. For flights of fancy we come into life fully fledged—but we moult early or are plucked in the course of our education, and we come to despise the arts of imaginative flight at which our distant ancestors were such adepts.

There are other ways of testing the theory. We may invent ' synthetic ' words by making (consciously) a pantomimic gesture with our tongue, or tongue and lips, and convert it into speech by grunting as we make the gesture. Of 19 such words, 18 were identified by Dr. Neville Whymant as actually occurring with the same meaning, and in the same or a phonetically allied form, in Polynesian, early Japanese, Indo-Chinese, or related languages. Thus, the tongue symbolising " to dance up and down to and fro " produced the synthetic word *li-lɔ* (lee-law). Dr. Whymant cited the Indo-Chinese words ' li-lo ' and ' li-lŭ,' meaning to dance; Prof. Louis Gray, of Columbia, cites the Sanscrit word ' lila,' meaning game or enjoyment; to these I would add the English word ' lulla-by,' meaning to ' dance (a child) up and down, to and fro ' in order to put it to sleep.

It is evident that if the pantomimic theory is true, it should appear (more or less) in all languages; a preliminary study has therefore been made of several ' unrelated ' language groups, namely, Indo-European, archaic Chinese, Sumerian (as written at Ur of the Chaldees), Semitic, Polynesian and allied languages, and the Hoka languages of the west coast of North America. In all of these, pantomimic words are found to be common. Thus, of the first 100 ' Aryan roots ' listed in Skeat's " Etymological Dictionary," 77 were found to be pantomimic, 12 were probably pantomimic, and only 11 showed no evidence. In Karlgren's " Analytic Dictionary of Archaic Chinese," 85 per cent of the 73 word-groups listed in the first twenty pages showed pantomimic structure, while in a list of comparable Polynesian and allied words, and Hoka words, published by Paul Rivet (" Les Malayo-Polynésiens en Amérique "), 86 per cent of the word groups showed the same principle.

Many words are common to each of these groups; thus, in all of them the word for *one* is made by an erect tongue gesture—symbolic of the index finger held up. Thus, Indo-European has ' oin,' archaic Chinese has ' iet,' Sumerian has ' aś ' (compare with our word ' ace '), Semitic has ' ahad,' Polynesian has ' ta,' Hoka has ' ta,' ' tsâ,' ' cha,' and forms like ' pun ' and ' pola.' In all of these the characteristic gesture is an erection of the tongue. A similar analogy is found in the case of the numerals *two* (made by a protrusion of the two lips) and *three* (made by protruding the tongue between the two lips).

Figs. 1 and 2 show the approximate tongue positions which correspond with the various English vowels and consonants; from these it is possible to draw the approximate tongue track of any given word so as to compare the gesture with its verbal meaning. It then becomes apparent that the same gesture may be construed in several different ways. Thus the tongue track may represent a direction of motion, or the outline of a form—it may be

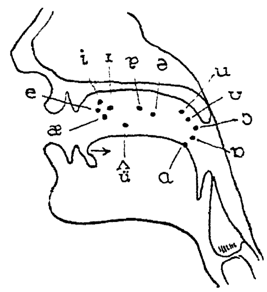


FIG. 1.

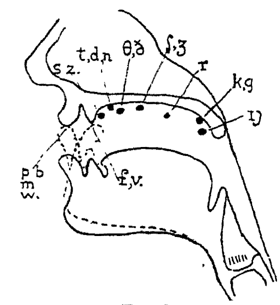


FIG. 2.

construed literally or figuratively—and, finally, it may be significant at the beginning, middle, or end of its course. For example, the archaic Chinese word ' kân,' of which the tongue track is shown in Fig. 3, means ' dawn ' (sun rising up) or the trunk of a tree (an up-swinging outline). Of figurative words may be instanced the Sumerian ' daria ' or ' duria,' meaning ' eternity,' in which the tongue track (see Fig. 3) forms a closed figure very similar to that of the hand gesture which deaf-mutes make to-day to express the same idea.

As to the significance of different parts of the tongue track, a good example is the word ' al '—formed by an upward thrust of the tongue—which may mean (1) ' up ' or ' high ' (Latin ' altus '), or (2) ' slack,' ' weak,' ' relaxed,' or (3) ' sweet,' that is, touching the palate as in tasting. In (1) the first part of the travel, in (2) the return journey, in (3) the mid-portion is significant.

It follows that ' homophones ' (words with two or more different meanings) are natural to human speech. It also follows from our theory that the many instances in which the same sound bears a similar meaning in (presumably) unrelated languages are not due to chance, but to a common method of production—if not actually to a common origin. It is not a matter of chance that in archaic Chinese ' ma ' meant mother (a sucking gesture) and that it also meant ' leach ' (one who sucks); or that ' kât ' meant ' cut,' ' suk ' meant ' suck,' ' pa ' meant ' father,' ' k'âp ' meant ' cup,' ' kap ' meant ' cap ' (of a seed or bud), and ' sieu ' meant ' sew ' (embroider); such coincidences are rather to be expected.

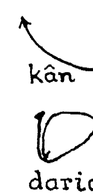


FIG. 3.

Surveying human speech, as a method of symbolising thought by gesture of the organs of articulation, we can scarcely escape the conclusion that it is still in a very barbaric and imperfect condition. It is full of ambiguities, anomalies, and homophones; it is cumbered (in most cases) by a quite unnecessary complexity of grammar and syntax; it mixes up voiced and unvoiced speech sounds with a corresponding loss in audibility, intelligibility, and musical and emotional quality.

The notation of language—especially in the case of English—is in worse case than the language itself, since in it our spelling now lags some centuries behind the spoken word. It is of prime importance for the advancement of human thought that we should now prepare for the systematic improvement and purification of our own language, so as to make it a more perfect and artistic method of symbolism for our thoughts. It is equally important that we should co-ordinate our efforts with those of the other English-speaking communities, so as to aim, in the future, at a standardised language and pronunciation with a rational spelling. The development of world broadcasting will make unification comparatively easy.

In the meantime we should ensure that our children are taught, in the first instance, to read and write phonetically, to articulate clearly, and to take an interest in the history and structure, the virtues and defects of our language, so that they may be prepared for the important task which lies before them.

Obituary.

Sir W. Boyd Dawkins, F.R.S.

By the death of Sir William Boyd Dawkins on Jan. 15, at his residence, Richmond Lodge, Bowdon, Cheshire, the sciences of geology and archæology have alike lost one of their most outstanding personalities. He was born on Dec. 6, 1837, at Buttington Vicarage, Welshpool, and was therefore just over ninety-two years of age at his decease. He was the only son of the late Rev. Richard Dawkins.

Boyd Dawkins was educated at Rossall and at Jesus College, Oxford: he won the (first) Baroness Burdett-Coutts Scholarship and graduated first class in natural science in 1860, and second class in Classical Mods., and was the first undergraduate to take geology in the honours school. Afterwards he became an honorary fellow of his College.

On leaving Oxford, Boyd Dawkins was given an appointment in 1861 as a field geologist on the staff of H.M. Geological Survey of Great Britain, and was allotted to the unit then surveying the south-eastern counties of England. In 1869 he resigned to take the post of curator to the Manchester Museum and lecturer in Owens College. He became professor of geology and palæontology in 1872 at the Victoria University, Manchester, and acted as a consultant on questions of mining and civil engineering involving geological problems. This post he held until 1908, but after his resignation he occasionally gave lectures on geology as an honorary professor.

Boyd Dawkins was not content to confine his researches to his own country, but was always keen on comparing the story of the rocks elsewhere, and so he travelled widely in North America and Australia during the long period, 1874–1890. It was on one of these visits that he gave his notable lecture at the Lowell Institute, Boston, on ancient man.

The discoveries by Boucher de Perthes of flints presumably worked by man in the valley of the Somme led to much controversy on both sides of the Channel, and was one of the contributory causes of the intensive search among the river gravels and cave deposits for reliquiæ of man. A distinguished band of observers, including Evans, Lyell, Lubbock, Prestwich, and Boyd Dawkins attacked this problem, and as a result raised the study of archæology from its former position as an amusement for the dilettante to that of scientific philosophy.

As a palæontologist Boyd Dawkins will always rank high, because he did not allow his conclusions to get beyond the region of legitimate inferences drawn from available evidences. As an archæologist he preferred the 'field-work' of exploration to theorising about results in the museum and library, and he therefore was always sympathetic with other workers who were labouring under the disadvantages of imperfections of the geological record, but was rather impatient in later years with some who held advanced views as to classification.

Boyd Dawkins' earliest work was his explorations of Wookey Hole, near Wells, in the Mendips, one of the great limestone caverns which was occupied by Pleistocene beasts. The fossil bones embedded in the cave breccias and cave-earths were a source of inspiration that led him to make a critical examination of that and of other caves in different parts of England, and the knowledge gained by the discoveries then made, and also those in the gravels and brick-earths of the river valleys was partly expressed in his classical monograph on the British Pleistocene Mammalia, published by the Palæontographical Society. In this piece of research he co-operated with the late W. A. Sandford. His "Cave Hunting," published in 1874, was dedicated to "The Baroness Burdett-Coutts as a slight acknowledgment from her first scholar." In this volume he described and discussed the notable discoveries of human relics not only in the caverns of England, but also in those of Aquitaine, Belgium, Switzerland, and other countries. His conclusions as to the antiquity and sequence of the different races of Stone Age man, expressed in this book, were more or less maintained to the last: namely, that the hunting and fishing race of cave-dwellers in the remote Pleistocene age in possession of France, Belgium, Germany, and Britain were probably of the same stock as the Eskimos, living and forming a part of a fauna in which northern and southern living and extinct species are strangely mingled with those now living in Europe.

Boyd Dawkins followed up his attack on the problem of prehistoric man by detailed examination of the fluviatile deposits of the European rivers, and to prepare himself for the inquiry he visited the more important museums in France and Italy and some of those in Germany and Switzerland, where he became a welcome visitor and friend of the curators. In the preface to his next work, "Early Man in Britain" (Macmillan, 1880), he acknowledges his debt to a number of geologists and archæologists who now rank among the fathers of the sciences, and include Sir Charles Lyell, Sir John Lubbock, Sir John

Evans, Dr. Thurnam, and Profs. Gaudry, Steenstrup, Capellini, Broca, Rütimeyer, and Virchow. In this book Boyd Dawkins draws the important conclusion that "it is unlikely that man lived in Europe in the Pliocene age" . . . but that "he appears just in the Pleistocene stage in the evolution of mammalian life in which he might be expected to appear." He divided palæolithic man into two great groups, river-drift man and cave man; a classification which is accepted in a broad way today, but the differentiation into the several stages that has resulted from the researches of later observers he was never inclined to accept; he was not, indeed, willing even to accept the classification of de Mortillet without reserve. "Early Man in Britain," however, is still in demand, and is an example of his extremely clear and logical presentation of facts, often of a highly technical nature, in such a way that the reader, while grasping the details, never loses sight of the main conclusions. It is eminently a readable book and impresses one as the work of a master-hand.

Boyd Dawkins was never content to study geology as pure science only, for he applied himself to its industrial and commercial applications, and acted in the capacity of 'expert adviser' on numerous questions involving geological knowledge. Like Prestwich, he devoted much time to the study of water supply to cities, and was consulted with regard to the schemes involved in those of London, Manchester, and Liverpool. His knowledge of the geology of the areas where engineering works were contemplated was employed in the schemes for the Manchester Ship Canal and the Humber Tunnel, and he was entrusted with the survey of the English and French coasts when the question of the Channel tunnel came up in 1882. His civic work in Manchester is still highly prized. As a result of his inferences, the search for coal in the concealed coalfield under Kent was largely undertaken, and his advice was often sought in working the Cheshire salt deposits.

His work was early recognised by his election to the Royal Society in 1867, and in after years numerous honours were bestowed upon him. The Geological Society of London, to which he was elected fellow in 1861, awarded him its Lyell medal in 1889, and very appropriately the Prestwich medal in 1918; he served on the council for four long sessions. He received the degree of D.Sc. from Oxford in 1900 and from Manchester the Hon. D.Sc. He was married twice, first in 1866 to Frances Evans (died 1921), by whom he had a daughter, and secondly in 1922 to Mary, widow of Mr. Hubert Congreve.

SIR HENRY TRUEMAN WOOD.

THE death of Sir Henry Trueman Wood on Jan. 7, at eighty-three years of age, removes from the intellectual and the administrative world a remarkable figure, who, in his prolonged years of great activity did much, indirectly, to shape the conditions under which many of us live. Numerous notable persons, still living, and eminent in the manifold fields in which he laboured, will sincerely regret the disappearance of his well-known tall and spare but distinguished figure, which is so well portrayed by Herkomer in his oil painting which hangs in the council room of the Royal Society of Arts, in the home which Robert Adam, one of the famous brother architects, built for the Society in 1774, in John Street, Adelphi. Here he did much for the Society, as secretary, for thirty-eight years, and was largely instrumental in bringing together a galaxy of talent which included Sir William Siemens, Sir Frederick Bramwell, Sir Frederick Abel, Sir Douglas Galton, Sir Richard Webster, Sir John Wolfe Barry, Sir William Preece, Sir William Abney, Lord Sanderson, and many others, all of whom were chairmen of the council during his secretaryship.

Born in 1845, Sir Henry was educated at Harrow, and at Clare College, Cambridge, where he was a scholar and twice won the Le Bas prize for the best English essay on a subject of general literature. On leaving the University he became a clerk in the Patent Office, where he acquired a knowledge of inventions which afterwards proved very useful to him and to others, while it enabled him to suggest very useful modifications in the patent laws which were dealt with by Parliament by a special Act in 1883. In 1872 he became editor of the *Journal of the Royal Society of Arts*, where, six years later, he became, in 1878, secretary, in which capacity he followed a so well known and eminent predecessor as Peter le Neve Foster, and where he occupied a seat which, more than a hundred years before, had been coveted by no less considerable a personality than Oliver Goldsmith, the author and poet.

Before concluding this account of Sir Henry Wood's services to the Royal Society of Arts, there must not be omitted some reference to the history of the Society, which he wrote. This was published by John Murray in 1913, and gives an illustrated and vivid account of the very varied activities of the Society from its inception in 1754, with references to the many eminent persons that were from time to time connected with it.

On his retirement from the secretaryship Sir Henry Wood was elected a member of the council, and served as its chairman for the year 1919-20. Later, in recognition of his signal services, he was nominated, by H.R.H. the Duke of Connaught, the president, to a vice-presidency, which he held up to his death, while at the same time members of the council raised a fund to provide an annual Trueman Wood lectureship, in connexion with which a number of brilliant addresses have been delivered by eminent men of science.

Sir Henry Wood took a leading part in the inauguration and management of many and great exhibitions, where the knowledge of inventions that he had gained at the Patent Office proved to him invaluable. Among these were the series of international shows started at South Kensington in 1871 by Sir Henry Cole, in close association with the Royal Society of Arts. Sir Henry edited many of the reports of these exhibitions, and served in

various capacities in connexion with them, which included the Health Exhibition of 1884, the Inventions Exhibition of 1885, and the Colonial Exhibition of 1886.

When it was proposed to hold an International Exhibition in Paris in 1889, the British Government declined co-operation owing to an objection by Queen Victoria, because the exhibition was to be a celebration of the taking of the Bastille in 1789, and of the French Revolution. It was proposed that the Society of Arts should undertake the organisation, and the Prince of Wales at first consented, but afterwards withdrew his consent. Eventually a committee was formed under Sir P. de Keyser, the Lord Mayor of London, as chairman, and Sir Henry Trueman Wood as secretary. The British section was successfully organised and carried through without Government aid, this being the first and only occasion on which the British section at a great international exhibition was established without Government funds. On the conclusion of this successful exhibition, Sir Henry received the honour of British knighthood, and that of an Officer of the Legion of Honour from the French Government.

In 1893 the council of the Royal Society of Arts was appointed a Royal Commission to administer a sum of £70,000 granted by the British Government to support a British Section at the Chicago Exhibition, and Sir Henry Wood went to Chicago and remained there throughout the holding of the Exhibition.

Nor must there be forgotten the contributions that Sir Henry made to technical education. In 1877 reports were asked for from him, as also from Prof. Huxley, Sir John Donnelly, Sir Douglas Galton, Sir William Armstrong (afterwards the first Lord Armstrong), and Sir George Bartley, for formulating a scheme of technical education for the committee of the City Guilds, who had recently taken up the subject. The suggestions of Sir Henry Wood were practically adopted, which led to his acting as secretary for some time to the committee of the City Companies.

In 1878, Sir Henry became secretary to Section G (Engineering) of the British Association, and continued to hold this office for seven years.

Sir Henry's interest in photography went back to wet collodion days, before the introduction of the dry plate. He read papers on photography both before the Royal Photographic Society and the Camera Club, and became president of the former Society from 1894 until 1896, after having previously been several years on its council. After this, it is perhaps not surprising to learn that for many years he served as a director on the board of Kodak, Limited, and until recently was chairman of the European section of that world-famous company. For more than a quarter of a century he was a well-known member of the Athenæum Club, and served on the executive committee, of which, for several years, he was chairman.

Amongst Sir Henry's other publications was a volume on "Industrial England in the Middle of the 18th Century"; a volume on "Methods of Illustrating Books," which, for its date, was full of information; besides numerous articles in magazines and in the daily press. Sir Henry leaves behind him a memory of a kindly but sagacious personality, with wide culture, both scientific and literary, and a record of unusual capacity and industry directed by a very sound judgment both as regards affairs and also concerning men.

A. A. CAMPBELL SWINTON.

MR. R. H. CAMBAGE, C.B.E.

BY the death of Richard Hind Cambage, which took place suddenly on Nov. 28, 1928, Australian science has lost one of its most prominent figures. He was born at Milton, N.S.W., on Nov. 7, 1859. Having been trained as a surveyor, he joined the public service in 1882, serving for three years as a draftsman in the Department of Lands. He was then, in 1885, appointed mining surveyor in the Mines Department, and his duties in this position carried him to all parts of the State and gave him the opportunity of obtaining a wide field knowledge of the botany of the State. In 1902 he became Chief Mining Surveyor, which position he held until he became Under Secretary for Mines on Jan. 1, 1916. He retired from the public service on Nov. 7, 1924, at the age of sixty-five years. He was a member of the Licensed Surveyors' Examination Board from 1903 until 1918, and also lecturer in surveying at the Sydney Technical College from 1909 until 1915. He was elected president of the Institute of Surveyors of New South Wales for three successive years, 1907–1909.

In the work of scientific societies in Australia, Cambage was one of the recognised leaders, and at the time of his death he was president of the Australasian Association for the Advancement of Science and of the Australian National Research Council. His wide and active interests are indicated by the offices he had held in scientific societies, amongst them being president of the Royal Society of New South Wales in 1912 and 1923, of the Linnean Society of New South Wales in 1924, of the Wild Life Preservation Society in 1913, and of the New South Wales Branch of the Australian Forest League in 1928. He was honorary secretary of the Australian National Research Council from 1919 until 1926, and one of the honorary secretaries of the Royal Society of New South Wales, 1914–1928 (except 1923 and 1924). As honorary secretary of the Australian National Research Council he did the lion's share of the organising work for the second Pan-Pacific Science Congress held in Melbourne and Sydney in 1923. For several years he was also a trustee of the Australian Museum. He was one of the few who are willing and able to shoulder the onerous duties inseparable from the successful management of scientific societies. He was elected a fellow of the Linnean Society of London in 1904, and in 1905 was created C.B.E.

Mr. Cambage's scientific work was chiefly botanical and may be divided into three sections. He had a very wide field knowledge of the Australian flora, and it may safely be said that there are few, if

any, botanists of the present century who have such a knowledge of the flora of a country so extensive as Australia. He had special knowledge of the genera *Acacia* and *Eucalyptus*, and the endemic plant assemblages peculiar to the island continent. He contributed to the *Proceedings of the Linnean Society of New South Wales* eighteen papers dealing with the local development of the flora in various districts. Of the twenty-nine papers he contributed to the *Journal of the Royal Society of New South Wales*, thirteen detailed his observations on the growth and development of *Acacia* seedlings. This work he developed systematically and aimed at completing descriptions of the seedlings of ten species each year. He had dealt with one hundred and thirty species in the papers already published, and, having discussed the commoner species, was beginning to find it more difficult to obtain well-authenticated seeds of the more uncommon species. Cambage was also keenly interested in the degree to which species of plants exhibited a preference for certain types of soil. His general ideas on the subject were indicated in his presidential address to the Linnean Society of New South Wales in 1925. Another topic on which his many observations made him competent to speak with authority was that of the origin of the Australian flora, and this he developed in his address to the Australasian Association for the Advancement of Science at the Hobart meeting less than a year before his death.

Keen interest in the earlier explorers resulted in some valuable contributions by Mr. Cambage to the work of the Royal Australian Historical Society. His knowledge of bushcraft, perfected by his experience in surveying, caused him to delight in attempting to follow, step by step, some of the journeys of the explorers, for he was scarcely ever so happy as when he had, from some random observation in an explorer's diary, been able to prove just where the explorer must have been when the entry was made.

Mr Cambage was a personality that will be sadly missed in scientific circles on account of his high principles. He possessed, to a rare degree, those qualities of tact, moderation, charitable judgment, and geniality which made him beloved by all his colleagues—many an awkward moment in the counsels of scientific societies has been safely negotiated by his tact. Only once in many years have I known him seriously perturbed, and then, in his usual tactful way, he set out to overcome the source of his perturbation with such success that few indeed knew anything about it.

A. B. WALKOM.

MRS. D. H. SCOTT.

BY the death of Victoria Henderina Scott, which took place quite suddenly at her home at Oakley, Hants, on Jan. 18, the Linnean Society loses one of its earliest women-fellows, and botany a keen and loyal supporter. Mrs. Scott was elected a fellow of the Linnean Society in February 1905, following the grant of the supplemental charter which removed the sex distinction. Her active interest in the Society's work was illustrated by an exhibition, shortly after, of a series of animated photographs, taken by the kinematograph, showing opening and closing of flowers, and other plant movements. Until recent years she was a frequent attendant at the meetings of the Society, and in 1911 gave a lantern exhibition of a new species of the fossil genus *Traquaria*. Communications on plant fossils and other subjects were also contributed to the *New Phytologist* and the *Annals of Botany*. In the preface to the second edition of the "Studies in Fossil Botany" (1909), Dr. D. H. Scott acknowledges the help of his wife in the preparation of some of the illustrations; and a similar service had been rendered in his "Introduction to Structural Botany" (1894–96).

Mrs. Scott also shared her husband's general botanical and scientific interests. We recall the International Botanical Congress at Vienna in 1905, to which they were delegates, the annual meetings of the British Association, where they were supporters of Section K, and of the South-Eastern Union of Scientific Societies, of which Dr. Scott has been president, in addition to the various activities of scientific societies and other functions in which they participated. Many botanists, at home and overseas, will recall the gracious hospitality of Dr. and Mrs. Scott at their charming home in Hampshire, and the interesting garden which Mrs. Scott loved to show to her guests. She will be greatly missed, and not in botanical circles only, for she had wide interests.

DR. WILLIAM JOHN BOWIS, whose death occurred on Jan. 25, was born in Nottingham in 1881, and entered the employment of Sir Jesse Boot in 1897, being engaged in the firm's analytical laboratories. From 1903 until 1905 he worked under Prof. A. Werner at the University of Zurich, and took part in Werner's researches on the co-ordination compounds of cobalt, receiving the Ph.D. degree in 1905. He afterwards returned to industrial work, and was largely responsible for the development of the soap and perfumery business of Messrs. Boots Pure Drug Co., Ltd., of which he became a director in March 1909. During the War he took a large part in organising the production of gas masks in Messrs. Boots' factories, and was made an O.B.E. in 1919. Dr. Bowis was a man of great ability and genial disposition, and the loss created by his death will be greatly felt.

WE regret to announce the following deaths:

Mr. T. H. Blakesley, for several years honorary secretary of the Physical Society of London, on Feb. 13, aged eighty-one years.

Dr. J. E. Eddison, emeritus professor of medicine in the University of Leeds and a former president of the Leeds Literary and Philosophical Society, on Jan. 27, aged eighty-six years.

Mr. Victor Plarr, librarian of the Royal College of Surgeons of England, Lincoln's Inn Fields, London, since 1897, on Jan. 28, aged sixty-five years.

Sir Bertram Windle, F.R.S., professor of anthropology in St. Michael's College, University of Toronto, on Feb. 14, aged seventy years.

News and Views.

DRAYSON'S astronomical conclusions, and their bearing on the ice age, formed the subject of a lecture by Lieut.-Col. T. C. Skinner at the Victoria Institute, on Feb. 18. Col. Skinner postulated that in 13,548 B.C. the obliquity of the ecliptic was about $35\frac{1}{2}°$, $12°$ more than at present, and assumed that this alone would suffice to cause an ice age. Quite apart from the astronomy, however, the meteorological inference is far from being self-evident. At present the winter climate of north-west Europe does not depend appreciably on the altitude of the sun; it is dominated by south-west winds from the Atlantic, and temperature is almost uniform from Ireland to the north of Norway. The south-west winds depend on the existence of an area of low pressure near Iceland, and the position of this Icelandic 'low' results solely from geographical factors. It does not change from winter to summer, so that there is no reason to suppose that a greater obliquity would displace it. It might be argued that a greater obliquity would make our winters more 'wintry'; that would simply mean that the Icelandic 'low' would become more intense. Our climate would be stormier, but no colder; our rainfall would increase, but not our snowfall.

THE solar control of our climate is already so small in winter that a further decrease would scarcely be noticeable. Any changes which might result in the winter climate of the coast would be offset by the greater power of the sun in summer, and Antevs has shown that a cool summer is more important for glaciation than a cold winter. On all counts one cannot but think that changes of the obliquity are inadequate to cause ice ages. Drayson's theory has the further consequence that for several thousand years the contrast of temperature between winter and summer should have been decreasing, and historical data are adduced in support of this. The historical data do not, however, furnish such a proof; there is not the slightest evidence that the contrast in Roman times was greater than it is now. Even in the post-glacial period, though there have been fluctuations, there is no trace of a progressive decrease in the annual range. Satisfactory support for Drayson's views is not forthcoming, therefore, from meteorology.

IN his address on the coming of age of the Eugenics Society, delivered at the Galton dinner on Saturday, Feb. 16, Major Leonard Darwin, who last year retired, after seventeen years, from the presidency of the Society, surveyed the changes which have taken place in the field of eugenics during his tenure of office. The most remarkable change has been the great advance in public opinion towards the recognition of the need for and practicability of eugenic reforms. Natural inheritance and the transmission of human qualities by means of tradition, though radically different processes, are often so alike in their results that the social policy to be advocated ought to be the same whichever of the two is regarded as the more important. The son of a criminal is ten times as likely to be a criminal as is the son of honest parents, and whatever is the actual cause of the fact, it follows that to reduce the fertility of criminals would confer a benefit at which all social reformers ought to aim. The fertility of the inefficient should be reduced, both for the immediate benefit to themselves and for the sake of posterity; while those doing good work of all kinds should have families fully large enough to fill their places when they die. The endless variety of good qualities could in this case be maintained. The important contrast in reproduction is that between the unskilled labourers and skilled workers of all kinds; this is so great that the children (and adults) of the worse-paid groups are drafted into the better-paid occupations at the astonishing rate of about two millions in three years.

THE absorption of this stream into the more cultural half of the community must be a most serious hindrance to national culture, and their continued removal leaves the less cultured half worse off than before. If the situation cannot be changed or reversed, Major Darwin foresees—and it is difficult not to agree with him—that while the physical surroundings of the people might continue for some time to improve, eventually our civilisation must show signs of decay. If any nation were to adopt a scheme of racial improvement, based on science and built up by common sense, and if it were to persist in this course, the improvement in moral, mental, and physical conditions would be so evident that all other countries would, Major Darwin suggests, follow such a lead.

NOT content with its achievement in erecting a landmark in the history of chemical industry, Imperial Chemical Industries, Ltd., has provided the Imperial metropolis with an outward and visible expression both of its work and of the status which that work has won for the company. Down by the River Thames, close to the Houses of Parliament (the division bell of which rings on the directors' floor) there has arisen in a surprisingly short time a noble building designed by Sir Frank Baines to combine beauty of form with commercial efficiency of a high order, and that degree of comfort which ministers to both; many will like to regard it as a new monument dedicated to chemists, physicists, engineers, and chemical engineers of the past, the present, and the future—a whim which will seem not altogether to lack reality when the carved portraits of Liebig, Priestley, Ludwig Mond, Alfred Mond, Harry McGowan, Lavoisier, Mendeléef, Cavendish, Dalton, and Berthelot are seen surmounting the arches of the main façades. Faraday is selected for special honour, for one of the panels on the massive main door—that intended to represent the achievements of modern science—will portray a lecture by Faraday at the Royal Institution.

IMPERIAL CHEMICAL HOUSE, which had to be designed while the construction progressed, contains 700 rooms, with a total floor area of 370,000 square feet, and its successful completion in less than one-third of the time which would normally have been required is no empty tribute to the efficiency of the scientific

co-ordination and control which has been applied to the task. Modern methods have been freely brought into service; ultra-violet rays will penetrate into the rooms; rubber flooring will contribute its special advantages; the artificial lighting will be exclusively of daylight quality. The requirements of a large staff have been amply and sympathetically considered; there is carving in the spirit of Grinling Gibbons and in the technique of the Wren period; the globe desk-lights bear a map of the world. These three representative facts in juxtaposition surely indicate that the company intends to advance beneath a banner inscribed "What is worth doing is worth doing well."

SINCE 1877, when Werner von Siemens and Sir William Thomson (Kelvin) discussed the feasibility of harnessing the Falls of Niagara and using the power for industrial purposes, it has often been pointed out that destroying the scenic grandeur of the Falls would be a great loss to the world. If the hydro-electric industry were allowed to proceed unchecked, towns full of factories would spring up, the woods would disappear, and where the Falls were would be a bare cliff. This has happened already in many places. Luckily both the United States and Canada have been considering the problem thoroughly for the past two years, and a treaty signed by the Prime Minister of Canada and the United States Minister in Canada has been drawn up containing effective measures for the preservation of the beauty of Niagara Falls and Rapids. This treaty will shortly come up for ratification. The power companies in Canada and the Unites States have offered to construct remedial works at their own cost, and would accept the limitation of the maximum amount of water that can be drawn from either side of the Falls. Surveys show that the escarpment is receding at an average rate of 3·7 feet per year, the maximum taking place at the notch of the Horseshoe Falls. Recession of the Falls and withdrawal of water for power purposes has resulted in baring the flanks of the Canadian Falls and thinning the flow over the American Falls. The remedial works would restore and enhance the scenic beauty of the spectacle, which attracts more than two million visitors annually. The redistribution of the water will modify the rate of erosion at the bend of the Horseshoe. It will also enable more accurate calculations to be made as to the amount of water that can be permitted to be used for industrial purposes.

THE statement prepared by the Controller of the London Telephone service for the Telephone Advisory Committee, describing the progress that has been made in the London area during 1928, shows that it has been satisfactory. The rate of conversion of the exchanges within the ten-mile circle from manual to automatic working is perhaps disappointing, as only six automatic exchanges with a capacity of 37,150 lines were opened during the year. There are now 130 exchanges in the London area, but in five years' time these will probably be 47 automatic exchanges. London is connected with most of the countries in west, south, and central Europe. These countries can also communicate with America through London. In America the service has been extended to all parts of Canada and to Mexico. The hours of service have been extended and a new radio channel has been utilised. A new submarine cable of the latest design connecting England with France has been brought into service during the year, thus bringing additional circuits of high efficiency to Paris within reach of telephone subscribers in Great Britain and giving them good communication facilities with towns in the south of France. The number of local calls made in 1928 was seven per cent greater than in 1927. The average number of trunk calls passing through the London Trunk Exchange was 8 per cent in excess of the preceding year. Attention is directed to the damage done by the fire in the Thames Embankment subway and by the recent explosion in Holborn. The former destroyed 200 main trunk and telegraph cables, and the latter damaged about twenty trunk cables. In both cases partial working was resumed within a few hours and full operation within a week.

IN Great Britain, Parliament has laid down a uniform charge for the transmission of telegrams irrespective of distance and of the number of retransmissions. In January of last year the Hardman Lever Committee reported that the average price paid per telegram was 14·76*d.*, while the costs amounted to 22·14*d.* Of the costs, 15·24*d.* was absorbed by administration and management, operating, delivery, etc. The Post Office engineers naturally hesitate to recommend the expenditure of additional capital in the circumstances. As there are sufficient channels to carry the traffic, even if they are not very satisfactory ones, they have been experimenting on novel methods of increasing their carrying capacity, and at the same time of diminishing the requisite number of officials. In a paper by W. Cruickshank on 'voice-frequency' telegraphs, read to the Institution of Electrical Engineers on Feb. 14, a system was described which has been developed since the War and has proved successful in other countries. In the system described by Mr. Cruickshank, the currents in the line are of the same order as those used in the telephonic transmission of speech. Full advantage is taken of the properties of the thermionic valve. Its entire freedom from electromagnetic inertia and its extreme sensitiveness to minute changes of voltage admirably qualify it as a telephone 'repeater.' The long distances between large towns on the American continent have fostered the telegraph habit. Elaborate terminal and intermediate apparatus form but a small fraction of the total capital cost. It pays, therefore, to superpose composite telegraph circuits on telephone 'pairs.' When a pair is reserved entirely for telegraphs, as many channels as possible are attached to it. Successful operation of twelve channels, each carrying a start-stop printing telegraph, has been achieved on many important routes. The Post Office in Great Britain is experimenting on similar methods, and hopes to increase the earning capacity of its plant.

THE third of the course of lectures on the early history of X-rays was delivered at the Royal Institution on Feb. 14 by Dr. Alex. Muller. Two years after

Röntgen's discovery in 1895, Wiechert was able to determine the velocity of cathode rays, and by measuring their deflection in a magnetic field he succeeded in evaluating the ratio between the electric charge and the mass of the cathode ray particles. In the Cavendish Laboratory, J. J. Thomson and his collaborators carried out a series of brilliant experiments, in which they proved the charge of ions in various gases to be a definite quantity independent of the nature of the gas. Within a few years of the discovery of X-rays, the existence of the electron was a well-established fact. Research on X-rays during this period had advanced comparatively little. All attempts to deflect these rays by prisms or lenses had failed. The laws of diffraction did not seem to hold for X-rays; and yet it seemed inconceivable that they should be corpuscular. The discovery that X-rays could be polarised was in favour of the wave theory, and later, direct attempts were made to estimate the wave-length of X-rays. It was not until 1913 that it was found that X-rays could be diffracted by crystals, but it showed definitely that X-rays can be regarded as trains of waves, of wave-length much smaller than that of visible light. Then came the revelation of the connexion between the frequency of X-rays and the energy of the cathode ray which made the X-ray or was made by it. This wonderful interchange would undoubtedly have taken years to discover if the old photoelectric effect had been the only means of approach. The relation between X-ray frequency and cathode ray energy involves a new universal constant, and introduces the quantum into the province of X-ray theory.

DR. BRADFORD HILL presented a paper on sickness in various industrial occupations before the Royal Statistical Society on Feb. 19. Using figures relating to printers, he showed that in short-period sickness influenza is the predominant cause, supplying a quarter of all the claims between ages sixteen and fifty, and approximately one-sixth of all the time lost through short periods of incapacity. Next in importance are the diseases of the respiratory system. In long-period illness the two predominant causes are phthisis and diseases of the nervous system. Illnesses of women weavers in Lancashire show that the serious excess of sickness known to exist amongst married women over that of single women is not largely due to illnesses associated with pregnancy. The cost of short-period illness is increasing year by year; in long-period illness there is a slackening rate of increase, but the final age group, 50-69, seems to be the slowest in reaching stability. A very much larger number of claims begin on the first days of the week than in the latter part of the week, while just above 50 per cent of 1400 claims ended on Saturday. This is open to two interpretations. Once a week has been broken into the worker tends to consider it not worth while to return to work. Alternatively, workers are loath to break into a second week's work, and therefore conclude their period of sickness at the end of a week whether they are fully recovered or not.

SINCE 1918 the important scientific researches carried out at the Universities of Prague and Brno have attracted some attention, although Czechoslovak men of science have hitherto been obliged to publish the results of their investigations in journals outside their own country. Consequently, many important memoirs have remained untranslated in the archives of the Czech learned societies, and it has been felt that this circumstance has not afforded the Czechs a real international reputation commensurate with their achievements. A new monthly journal, entitled the *Collection of Czechoslovak Chemical Communications*, has therefore been founded under the editorship of Prof. E. Votoček and Prof. J. Heyrovský. The *Collection* will contain original communications (in French or English) on pure chemistry which have not previously been published in any widely known language. In addition, there will be a bibliography of all the chemical publications in Czechoslovakia, and reviews of Czech scientific books will also be given. The first number has appeared and contains an article by Prof. J. Štěrba-Bohm and S. Škramovský on the complex oxalates of scandium, one by Prof. J. Heyrovský and S. Berezický on the deposition of radium and other alkaline earth metals at the dropping mercury cathode, and two papers by Prof. Votoček and his collaborators on rhamno-convolvulic acid and 3 : 12-dioxy-palmitic acid (which is derived from rhamno-convolvulic acid). It may be remarked that Prof. Štěrba-Böhm has made a life study of the chemistry of the rare element scandium and his present communication on its double oxalates is of particular interest. The authors and editors are to be congratulated upon the clarity and excellence of the language and upon the high quality of their first issue. The annual subscription for the *Collection* is 170 Kč or £1.

IN 1886 the late Duc d'Orleans was driven by law from France, where he had spent his childhood, and for forty years he lived an exile in England. He was a traveller and sportsman, and it was pleasing to learn that no sense of bitterness against the land of his fathers prevented him from bequeathing to the National History Museum of France his unique collection of trophies. That collection has now been successfully transported to Paris—no mean undertaking—and there has been arranged and thrown open to the public. All familiar with the Duc and his enthusiam for natural history, and with the steady development of his collection in the most advanced and spectacular mode of taxidermy, under the skilled guidance of Mr. Burlace, of Messrs. Rowland Ward, Ltd., will realise how greatly the addition must add to the popular attraction of the Paris Natural History Museum. Apart from rare and valuable specimens, such as the great panda from Tibet and the mountain bush-buck from East Africa, the collection includes an unrivalled series of pictorial groups ranging from the polar bears of the Arctic to many African scenes of bird and mammal life, and an Indian group of elephant and tiger. The scenes, which record incidents in the travels of the Duc d'Orleans, were built under his minute direction and are a standing credit to British taxidermy. A short illustrated account of the collection, by the Director of the Museum, Louis Mangin, appears in the *Revue générale des Sciences* for Jan. 15.

THE extraordinary extent of the repercussions of commerce upon living creatures has recently been illustrated by the appearance in Smithfield Market of a consignment of rare birds from the mountains of Central Asia. They were Altai snowcock, game-birds in form like overgrown black-grouse, but of a predominant grey colour. Little is known of the habits of the species, and few specimens existed even in the British Museum, so that opportunity was taken to replenish the collections there and at the Royal Scottish Museum. An interesting article on these birds and the habits of related species, written by N. B. Kinnear, appears in the *Natural History Magazine* for January. In summer the birds live on barren hill-sides, above the limit of forest growth to 17,500 feet, but in winter, snow drives them downwards as low as 7000 feet. As a rule they live in small coveys of six to seven, but occasionally they appear in larger flocks of thirty or so, always tame and easy to approach, yet generally guarded by an outpost perched on a boulder or some other position of advantage. We wonder how many of the frequenters of Smithfield Market who ate the birds dreamed of the story behind their capture and transport from the Altai mountains. The writer can vouch for their excellence as food, though it may be that romance added savour to the dish.

A REMARKABLE and instructive experiment in connexion with the education of the blind has been carried out by Mr. N. D. Cuthbertson, librarian in the Royal Scottish Museum. Following upon a series of Nature rambles arranged by him for Girl Guides, he was induced to conduct a similar series for blind members of the organisation belonging to the Royal Blind School. The rambles were mainly botanical, and while the march of the seasons was emphasised by concentration upon studies of foliage, flower, or fruit, attention was always focused upon significant structural characters. It was a happy thought to test the result of the teaching by getting the blind ramblers to write accounts of their experiences. Some of these essays have appeared in *The Teacher of the Blind*, and they show not only that the pupils thoroughly enjoyed the excursions and learned from them, but also that their tactual appreciation of fine differences in structure, such as the presence or absence of fine hairs on stems or leaves, was at least as efficient as the visual impressions of seeing pupils. An excellent essay written by an excursionist who was both blind and deaf, indicates the pitch which blind-deaf education has attained, and shows very clearly that a general extension of the Nature ramble movement to blind scholars and their seniors would add a new pleasure and mental stimulus to their existence.

DR. A. E. DUNSTAN delivered a lecture before the Junior Institution of Engineers on Feb. 8, on recent developments in the art of oil cracking. He said that cracking as applied to oil is of British and not American origin, as commonly supposed, having been first employed in 1862 in Scotland, where a plant working at 20-lb. pressure was used to turn gas oil into kerosene. The term 'cracking' is American, and was suggested by the noise made by oil inadvertently allowed to remain in an overheated still. Last year 30 per cent of the gasolene or petrol was obtained by cracking crude oil, and a further 20-30 per cent from cracked natural gasolene. Although the world's consumption of oil is very great, during the past seventy years only about two-thirds of a cubic mile has been taken out of the earth. The researches of the chemist, aided by improvements in plant, have resulted only this year in the ability completely to break down the constituents of oils and gases and the reassembly of these components in forms which at the moment may be more profitable commercially. There are three essentials in oil distillation over which rigid control must be possible, namely, temperature, pressure, and time. An increase of 10° C. in temperature reduces by one-half the time required. The choking up of a pipe-still system by coke residue has been eliminated by using a pulsating flow produced by an auxiliary pump.

IN the *Engineer* for Feb. 8, Mr. Haanel, Chief of the Division of Fuels and Fuel Testing, Ottawa, gives a description of the new fuel research laboratories erected for the study and investigation of Canadian fuels, solid, liquid, and gaseous. Beside the chemical laboratories, which contain the usual apparatus for making analyses, determining calorific values and examining physical properties of fuel, the station will include a commercial by-product recovery coke plant, an experimental domestic heating plant, a large scale powdered fuel steam-generating plant, a commercial scale briquetting plant, and a large-scale coal-washing plant. The burning of solid fuels in the pulverised form has assumed great importance in recent years, one of the advantages of the system being the possibility of utilising low-grade coals which cannot be satisfactorily burned by hand firing or on any mechanical stoker. Another important feature of the work of the new laboratories will be the study of low-temperature carbonisation processes as applied to Canadian coals, and, as occasion arises, it is proposed to test out the most promising processes, while other matters to which attention will be paid are oil cracking and refining and the production of motor oils, lubricating oils, waxes, etc., and the distillation of oil shales such as those found in the provinces of Nova Scotia, New Brunswick, and elsewhere. The new station is designed to carry out experiments in the interests of the development of the coal resources of the whole Dominion.

THE Report of the Director of the Institute of Biological Research at the Johns Hopkins University indicates robust vitality and a vigorous tackling of many biological problems of first-rate importance. The work falls into two broad groups, general biology and human biology. Amongst the former are included statistical studies upon the growth of experimental populations, the duration of life, the factors influencing the rate of reproduction in *Drosophila*, individual growth, and the relation of organic (constitutional) pattern to life processes. The human

investigations deal with the factors influencing longevity, senescence, and senility, the influence of alcohol upon health and longevity, the constitutional factor in disease, biometrical studies on cancer, analysis of population growth, and human genetics. The programme seems greater than could reasonably be tackled, but the organisation of the Institute has now been completed according to the original plans, so that the staff of eighteen scientific workers, including the Director, Dr. Raymond Pearl, has been able to settle down to the undisturbed prosecution of the plan of research. In addition, however, the Director has found time to take a large part in the formation of an International Union for the Scientific Investigation of Population Problems, and to found a new journal, *Human Biology: A Record of Research*, a quarterly.

A PUBLICATION of the National Museum of Wales has just been issued which will be of great interest and value to geologists all over the world. It is by Dr. F. J. North, the Keeper of the Department of Geology, and is entitled "Geological Maps: their History and Development, with special reference to Wales." Written in scholarly fashion, and illustrated with a wealth of plates and text-figures, it is, at the modest price of one shilling, at once the cheapest and best book on its subject. The first part deals with the evolution of geological maps in general: the birth of the idea, the development of practical methods, the law of superposition, and the period of achievement, culminating in the work of William Smith. The next section is devoted to geological mapping in Wales, but so much of the pioneer work was carried out in Wales, that the history of Welsh geology is closely bound up with the history of geological progress in general. The heroic period of Sedgwick and Murchison, for example, receives full and sympathetic treatment. A feature particularly valuable to field workers is a classified list occupying 34 pages, giving details of all the maps that have appeared officially, in scientific journals, and in separate works during the past twelve decades. Finally, there is a bibliography and index.

THE growth in Britain of a desire to preserve the beauty of the countryside from destruction and disfiguration and to encourage walking on the moorlands and mountains is well exemplified in the excellent little Handbook of the Ramblers' Federation of Manchester and District. The book contains a record of many movements, of which some were successful, to preserve footpath rights and access to wild country. There are also interesting articles on the vegetation of the Peak district, the ancient monuments of Lancashire, national parks and reserves, and other subjects. The growth of the Federation is a healthy sign of the appreciation of open-air life and a welcome check to the ugliness of urban growth in many parts of the country.

A DISCUSSION on "Ultra-Microscopic Viruses infecting Animals and Plants," to be opened by Sir Charles Martin, will be held at the Royal Society on Thursday, Feb. 28, at 4.30 P.M.

ON Saturday afternoon (Mar. 2) at three o'clock, Sir Ernest Rutherford delivers the first of four lectures at the Royal Institution on molecular motions in rarefied gases. On Tuesday (Mar. 12) Dr. Stanley Kemp will commence a course of two lectures on Antarctic whaling investigations. The Friday evening discourse on Mar. 1 will be delivered by Sir Robert Robertson on infra-red spectra, and on Mar. 8 by Prof. T. F. Tout on the place of women in later medieval civilisation.

THE Ministry of Health has issued a Memorandum (Memo. 131 A/T.) on the treatment of tuberculosis, containing an analysis of work done during the year 1927 under the schemes of local authorities. Authorities concerned should find the memorandum of value in considering whether their schemes for the treatment of tuberculosis need revision in any respects in order to secure the most efficient arrangements and the best return for the money expended for the purpose.

THE report of the map publications and office work of the Survey of India for the year 1927–28 shows that steady progress is being made in the publication of modern maps. Considerable parts of the Punjab, peninsular India, the Ganges valley, Bengal, Assam, Lower Burma, and some other parts of the Indian Empire are now published on both the half-inch and one-inch scales. The quarter-inch scale is also making progress, and practically the whole of India and countries lying to the immediate west are now available on the one-million scale. The report contains keys to all the maps of India that are on sale.

THE eighth Annual Report of the Scientific and Industrial Research Council of Alberta, covering work to December 1927, has been issued from the University of Alberta, Edmonton. The report indicates that the province is energetically developing its resources in a scientific manner. The main part, dealing with fuels, contains data on the coals and lignites of Alberta. It was shown that good coke could be made from the coal, while the lignite could be briquetted. The geological section has been extending its study of the mineral resources of the State, while the engineering section has shown that an improvement of the gravel roads could be made by the application of bitumen (preferably emulsified) obtained from the local tar sands.

Two bulky volumes, Parts 1 and 2, constitute the thirteenth and fourteenth Reports of the Director of Veterinary Education and Research, Department of Agriculture, Union of South Africa (Pretoria, 1928). Some forty papers are included, dealing for the most part with diseases of animals. Sir Arnold Theiler and Dr. Robinson have investigated outbreaks of a somewhat mysterious disease occurring in mules and characterised by paralysis of the locomotor system. They find that it is a form of botulism due to the ingestion of the toxin of *Bacillus botulinus*, the exact 'type' of which has yet to be determined. The poisoning was derived from the consumption of infected fodder. The existence of equine botulism in South Africa is of interest, because about a year ago

Sir Arnold Theiler and his collaborators showed that 'lamsiekte,' an important disease of cattle, is also a form of botulism (see NATURE, June 18, 1927, p. 904).

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A second assistant chemist in the Hull Corporation Laboratories —The City Analyst, 40 Lowgate, Hull (Feb. 28). A city analyst for the City of Birmingham—The Town Clerk, Town Clerk's Office, Birmingham (Mar. 1). A junior assistant in the photometry division of the National Physical Laboratory—The Director, National Physical Laboratory, Teddington (Mar. 2). An assistant master qualified in mathematics, at the Technical Institute, Gillingham—R. L. Wills, 15 New Road Avenue, Chatham (Mar. 2). An assistant in the Building Department of the Northern Polytechnic, Holloway—The Clerk, Northern Polytechnic, Holloway (Mar. 2). A lecturer in chemistry at the Cheltenham Technical School—The Principal, The Technical School, Cheltenham (Mar. 4). A temporary chemical assistant in the Public Health Department, L.C.C. —The Medical Officer of Health, County Hall, Westminster Bridge, S.E.1 (Mar. 4). A (male) junior assistant under the Directorate of Ballistics Research, Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18. A chemist at the Test House, Kidbrooke, of the Air Ministry Aeronautical Inspection Directorate—The Secretary (I.G.), Air Ministry, W.C.2. A male technical assistant in chemistry under the Chemical Warfare Research Department of the War Office—The Chief Superintendent, Chemical Warfare Research Department, War Office, 14 Grosvenor Gardens, S.W.1. A laboratory assistant in the Naval Ordnance Inspection Laboratory, Holton Heath, Dorset—The Head Chemist, Naval Ordnance Inspection Laboratory, Holton Heath, Dorset. A chief building trade instructor at the Army Vocational Training Centre, Aldershot—The Commandant, Army Vocational Training Centre, Aldershot. A male technical assistant in the Chemical Warfare Research Department of the War Office, and a male laboratory assistant at the Experimental Station, Porton—The Chief Superintendent, Chemical Warfare Research Department, 14 Grosvenor Gardens, S.W.1.

Our Astronomical Column.

THE PROPOSED FIXED EASTER.—The measure relating to this subject that was passed by Parliament last year postponed the date when it should come into operation until there was general agreement on the subject among the principal Christian bodies. A step in this direction was taken on Feb. 14, when the Upper House of the Convocation of Canterbury unanimously passed a resolution in favour of Easter being kept on the Sunday after the second Saturday in April. It was noted by the Bishop of Truro, who proposed the resolution, that the chief difficulty would probably lie with the eastern bodies collectively known as the Greek Church. Their conservatism was well known, as evidenced by the fact that they had held aloof from the Gregorian reform of the calendar for three and a half centuries; but the fact that they had now come into line with the West on this point gave hope that they might admit further change. In this connexion it has been noted as a hopeful omen that practically the whole of Christendom will keep Easter on the same date this year. The rule now adopted in Greece does not bring this about every year, since they follow the true moon, while the West follows the 'ecclesiastical moon,' as given by the tables of Clavius.

As regards the largest Christian community, that which owns allegiance to the Pope, there have been reports during the present pontificate that the Vatican Council, which closed abruptly in 1870 owing to political events, might resume its session, in which case there is little doubt that this question of a fixed Easter would come up for discussion. It is unlikely that any insuperable obstacle to the change would be found on doctrinal grounds; but there is not unanimity on the question, and it is by no means certain that a favourable decision would be reached.

AN EARLY OBSERVATION OF FORBES'S COMET.—Mr. M. Yamasaki, of the Misusawa Latitude Observatory, Japan, informs us that he detected this comet with a 7-inch reflector on a date that he gives as Oct. 27·81 U.T. Unfortunately, he did not communicate the discovery to anyone until Nov. 10, when he wrote to the Tokyo Observatory; had he announced it at once by telegraph, the arc over which the comet was observed would have been considerably extended. He gives the position on Oct. 27·81 as: R.A. $11^h\ 1^m\ 23^s$; N. Decl. $8°\ 32{\cdot}2'$. A calculation made from the latest orbit of Mr. H. E. Wood, which includes observations from Nov. 21 to Dec. 20, and is certainly very near the truth, shows that the comet was very close to the position given by Mr. Yamasaki on Oct. 26·81 U.T., but was 100′ away from it on Oct. 27·81; so either Mr. Yamasaki has given the wrong day for his observation or else the wrong position; the former supposition is by far the more probable, as it gives agreement both in R.A. and Declination.

If Mr. Forbes had not found the comet, it is very doubtful whether it would have been recovered from Mr. Yamasaki's announcement; for by the time he wrote to Tokyo it was some twenty degrees distant from its position when he saw it, and no clue was given as to the direction or rate of its motion. Promptness in the announcement of cometary discoveries is highly desirable.

THE PARALLAX OF ALPHA CENTAURI.—The parallax of this interesting star, so long regarded as our nearest stellar neighbour, has been investigated photographically by Dr. H. L. Alden, at the Johannesburg Station of Yale University Observatory. The results are given in the *Astr. Jour.*, No. 913. It is the first time that this parallax has been determined by modern photographic methods, and it is satisfactory to find that the result is in perfect agreement with that of Gill and Elkin from the Cape heliometer: that was $0{\cdot}758'' \pm 0{\cdot}010''$, while Alden's is $0{\cdot}757'' \pm 0{\cdot}006''$. The parallax of Proxima Centauri, the distant companion that Dr. Innes found at a distance of $2°\ 11'$ from the bright star, was also measured and found to be $0{\cdot}785'' \pm 0{\cdot}005''$. The weighted mean of the previous results of Voûte and Innes was $0{\cdot}765'' \pm 0{\cdot}021''$. Alden adopts the combined result $0{\cdot}783'' \pm 0{\cdot}005''$. This star is therefore nearer to us than Alpha Centauri by one-seventh of a light year. Its photographic absolute magnitude is 18·5, the visual being 16·5; its linear distance from Alpha is about 14,000 astronomical units.

The paper also contains a discussion of the relative masses of the two components of Alpha. The brighter star is found to have a mass 1·06 times the sun's, and the fainter 0·92 times. It is pointed out that the period 1945–1952 will be specially favourable for determining the relative masses, as the curvature of their relative motion will then be great.

Research Items.

Gebel Haraza.—In *Sudan Notes and Records*, vol. 10, Mr. H. A. Macmichael contributes some notes on the inhabitants and antiquities of the range of hills in the Sudan known by this name. The nomenclature of the peaks—each has its own name—is generally non-Arabic, and the proportion roughly represents the relative proportion of Arabic and non-Arabic blood. The present inhabitants are a mixture of Rekâbia and some other race. The Rekâbia migrated from Mundera on the Nile in the eighteenth century and expelled most of the previous inhabitants, intermarrying with the women who remained. They are particularly able and acute. The other inhabitants call them Nuba or Shaberga and they sometimes admit relationship with the Nuba of Kordofan. They say their fathers found a still earlier and alien civilisation at El Haraza, and as a matter of fact the earlier inhabitants were far more advanced in civilisation, working in stone, making, for example, rings of stone (granite, flint and sandstone) and hollow conical ornaments of unknown purpose, now used as amulets. Ironworks are still to be seen with back walls ranging in tiers, all with a number of concavities, presumably each intended for a single worker. Cylinders of hard burnt clay for use with the bellows lie about in large numbers. These earlier tribes produced rock pictures which are to be seen in three spots ; some are in a red pigment and some in a white. At Kurkeila they are chipped roughly and indistinctly on the rock surface. The appearance of the camel suggests they may be fairly modern. The pictures at Shalashi are on the roof of a cave formed by a fallen boulder. They are beautifully proportioned and represent men on horseback, the horses being of the type of the Egyptian paintings, while the men have broad chests and narrow hips like the Egyptian figures.

Solutrean Sculpture.—M. Henri Martin, who for many years has been engaged in excavating sites in the valley of the Roc (Charente), brought to light in 1927 a remarkable series of five sculptures, perhaps the finest ever discovered together, in a rock shelter situated on the slope of a cliff on the right bank of the river. These have now been deposited in the St. Germains Museum, and, with other features of the site, are described and very fully illustrated in Mem. 5 of the *Archives de l'Institut de Paléontologie humaine* of Paris. The area constituting the site contained two cave stations and two shelters, but the talus yielded a considerable amount of material. In one of the shelters three skeletons of Chancelade type were discovered. The other had evidently been used as a workshop. More than two thousand implements, flakes, ornaments, etc., were recovered from it. Traces of a hearth were also found. At the back of the shelter were large blocks of rock which had fallen either before or early in the occupation of the shelter, and on these were the five sculptures forming a frieze. They are executed in high relief and depict Bovidæ or pseudo-Bovidæ, horses, and men. Certain remarkable features are to be noted. In the first place, as regards situation, these sculptures are in full sunlight and not in the darkness of a cave like Magdalenian art. Secondly, while the human figures are poorly and conventionally represented, the animals are represented with the greatest fidelity. This is to be seen especially in the accurate swell of the joints and the play of muscle. The cloven hoof of the bulls is always shown. Thirdly, the horses are pregnant. While, therefore, the situation differentiates these drawings from the Magdalenian, to which a magical purpose is attributed, their fidelity and truth suggest a delight in creation for its own sake. Yet the pregnancy of the horses, as well as one human figure, possibly masked and dancing, suggest a religious motive in relation to fertility.

Tuberculosis in Wild Animals.—The existence of tuberculosis in wild animals living under natural conditions is practically unknown ; a few instances have been recorded in ground squirrels in California. Messrs. R. Paine and G. Martinaglia, of the South African Veterinary Service, now report cases among wild buck in the Albany District of Cape Province (*Journ. S.A. Veter. Med. Assoc.*, vol. 1, No. 2, 1928, p. 87). Five cases were met with in the kudu antelope (*Strepsiceros strepsiceros*) and one in a duiker ewe (*Sylvicapra grimmi*). Five out of the six cases were fully investigated and yielded the bovine strain of the tubercle bacillus.

Life Cycle of *Echinobothrium*.—J. S. Ruszkowski (*Bull. Int. Acad. Polonaise Sc. Lettres*, 7 B ; 1928) describes a new species of *Echinobothrium* (*E. benedeni*) from the intestine of two species of skate (*Raia asterias* and *punctata*) taken at Roscoff. By examining the undigested food in the stomach of the skate as soon as possible after capture, he found three samples of the prawn *Hippolyte varians*, in which altogether were four larvæ of *Echinobothrium*. The larvæ of *E. benedeni* and probably those of other species have numerous well-developed crotchets on the head, but none on the cephalic peduncle. There is probably only one intermediate host in the life cycle of the Echinobothriidæ in general and of *E. benedeni* in particular, an important difference from the Bothriocephalidæ, in which two intermediate hosts are necessary.

Salmon of the River Conon.—Mr. W. J. M. Menzies, Assistant Inspector of Salmon Fisheries for Scotland, describes the results of his examination of the salmon of the River Conon in 1927 (Fishery Board for Scotland, Salmon Fisheries, 1928, No. 8). This river, with its attendant lochs, is a difficult one for salmon, as most of these lochs are barred by impassable falls and the tributary streams are in consequence inaccessible. Ascending salmon have a hard life and a rough passage, the scarcity of food in the upper waters due to high ground, lack of lochs, and rough, rocky bottom making life none too easy for the parr. The result is that these parr grow slowly, and consequently a high average age of migrating smolts is shown. The author has examined more than 1100 sets of scales, forming a good representative proportion of the catches. In 1927 the largest fish caught in the nets weighed 35½ lb., whilst one barely half a pound heavier was caught in 1928. The largest caught by a rod in recent years weighed 30½ lb. and was 41·25 inches long. The salmon in the Conon are predominantly of the younger age groups and return after spending a minimum of time in the sea. The catch of the early season is composed almost entirely of small spring fish which have spent nearly two complete years in the sea. In May these are intermingled with small summer fish in about the proportion of two to one, in June small summer fish with grilse in the proportion of about two to one, and in July and to the end of the season grilse predominate. Out of 67 fish that had previously spawned, only 3 had spawned more than once, two came up as grilse and then spawned in two successive years, and one, after appearing for the first time as a small

spring fish, spawned twice, but spent a complete year in the sea between each visit to fresh water. This fish must have been nine years old when captured, and weighed 20·5 lb. The average age for smolts in the Conon is very high, 42 per cent being two years, 53 per cent three years, 4 per cent four years and a few five years of age at migration. Their calculated lengths are low. They had a specially vigorous growth in the sea. The average size of the grilse and summer fish is large and the grilse are exceptionally fat.

MORPHOLOGY OF THE SKULL OF GNATHOSTOMATOUS FISHES.—Mr. E. Phelps Allis (*Jour. Anat.*, vol. 63, pt. 1, 1928) gives a detailed review of the present position regarding the morphology of the skull in gnathostome fishes, with special reference to the origin and homologies of the pituitary fossa, the myodome and the trigemino-facialis chamber. He first of all gives a connected and detailed statement of his own theory, based on his work on *Ceratodus*. This is followed by a chronological review of the more important work on the subject from Gegenbaur in 1872 to de Beer in 1927. The author then discusses the evidence derived from this work and its bearing on his own theory, particularly in the light of the criticisms of de Beer. He concludes by re-affirming in all its essentials his interpretation of the morphology of the gnathostome fish skull first published in 1914. His paper is a valuable and critical statement of the present position of the matter and a notable contribution to vertebrate morphology.

STUDIES OF CHLOROSIS IN FRUIT TREES.—Mr. T. Wallace presents the results of further studies of this subject (see NATURE, Oct. 13, 1928, p. 587) in the *Journal of Pomology and Horticultural Science*, **7**, pp. 172-183 and 184-198, December 1928. In the case of lime-induced chlorosis, he shows again, by a chemical examination of leaves, wood, and bark of the current season's shoots, that whilst in the chlorotic leaves, in this case of pear, plum, and raspberry, the ash content on dry matter is high, the relative proportions of potassium and calcium are different from those obtaining in the green leaves, potassium increasing and calcium falling in the chlorotic leaf. These characteristics of ash distribution hold also for the bark, but not for the wood of the chlorotic shoots. On the other hand, in the case of a chlorosis of plums, due to deficiency of potassium, this element was poorly represented in the ash of the leaves of the chlorotic plants, which also had a low ash content on dry weight. In the case of this type of chlorosis, which occurred on soils where leaf scorch trouble might also be anticipated, spraying with ferrous sulphate was ineffective as a control, whilst potash manuring was a successful remedial measure.

ROOT INFECTION OF TEA PLANTS.—As a result of a visit to Nyasaland in February and March 1927, Dr. E. J. Butler has written a "Report on some Diseases of Tea and Tobacco in Nyasaland (issued by the Department of Agriculture, Nyasaland, Zomba, July 1928), which gives a general account of the diseases of these crops met with on his tour, which should be of considerable interest to all growers of tea and tobacco. An interesting feature in the report on tea diseases is the proportionately large space that has to be devoted to infectious diseases that appear to spread via the root systems. *Armillaria mellea* is of course one of the most striking of these parasites, and a very clear account is given of the appearance of trees which have fallen victims to this pest. But stumps also appear to be rotted by *Ustulina zonata*, which has elsewhere proved a parasite to rubber (*Hevea*), whilst an internal root-rot *Botryodiplodia theobromæ*, when present, seems to be an even more deadly foe than either of these other parasites in the light of the planters' observations. Dr. Butler discusses the symptoms and manner of spread of an obscure root disease, often attributed to this last fungus, but concludes that the identity of the pathogen in this case must remain an open question for the present. Root diseases are probably all the more prevalent from two cultural practices. When ground is cleared, removal of the plant cover causes rapid washing out and impoverishment of the soil. As a result, root growth is poor and the root system more susceptible. Then, on the other hand, tree stumps are not cleared out after felling, and, from his wide experience, Dr. Butler describes in an interesting manner the prevalence of centres of root infection which radiate from rotting stumps, and from stumps of some species of trees more frequently than others.

FOSSIL FRESHWATER MUSSELS FROM PERU.—W. B. Marshall describes (*Proc. U.S. Nat. Mus.*, vol. 74, art. 3) some fossil pearly freshwater mussels from deposits at the head-waters of the Upper Amazon, Peru. The exact geological horizon from which they were obtained has not been definitely settled, but Conrad considered that they could scarcely be later than Tertiary. Brackish water forms are associated with these mussels, which must have been swept down from higher levels by floods. Five new species are defined, for which the author creates two new genera: *Prodiplodon* and *Eodiplodon*.

COLORATION OF MOLLUSCAN SHELLS.—E. W. Bennett records some observations on New Zealand Mollusca in *Records of the Canterbury Museum* (vol. iii. p. 185, November 1928), and concludes that in most shelled mollusca the degree of pigmentation is in proportion to the degree of exposure to light in the natural habitat of the species in question. He regards the pigment as a protection, probably against ultraviolet rays. Although pigment, "unfortunately," as Mr. Bennett says, usually has disappeared from fossils, still its occasional recorded presence may throw some light on the habitat of the extinct species.

ANALCITE ROCKS OF AYRSHIRE.—Dr. G. W. Tyrrell has published an important contribution to the petrology of analcite-bearing rocks (*Quart. Jour. Geol. Soc.*, pp. 540-567; 1928). The rocks of the Ayrshire province are generally thoroughly basic, ranging from crinanite and teschenite through picrite to peridotite. It is therefore particularly interesting to find more felsic rocks—analcite-syenites—occurring in differentiated sills of crinanite as bands, schlieren, and veins. The occurrences described, of which that at Howford Bridge, Mauchline, is the most important, are all of late Carboniferous or Permian age. Variation within the sills is ascribed to crystallisation-differentiation aided by the settling of heavy titanaugite-ilmenite intergrowths. Several continuous and discontinuous reaction series have been traced, and it is clearly shown that a certain amount of lime must thereby have been restored to the residual magmatic liquor, along with the usual alkalis, silica and volatiles, leading to the final crystallisation of analcite, soda-lime zeolites, and prehnite. It is noted that the great development of analcite-syenite within the Howford Bridge sill is concomitant with the impoverishment of the associated crinanite in analcite. In the other sills, the crinanites are richer in analcite, and analcite-syenite is correspondingly sparse.

TAJIMA (JAPAN) EARTHQUAKE OF 1925.—This destructive earthquake occurred at 11 h. 10 m. 49 s.

(2 h. 10 m. 49 s., G.M.T.) on May 23, 1925, in the boundary district of the provinces of Tajima and Tango. It was followed, on Mar. 7, 1927, by the much stronger Tango earthquake with its epicentre only 11 miles farther east (NATURE, vol. 122, p. 36). The Tajima earthquake is the subject of valuable memoirs by Prof. B. Koto (*Tokyo Imp. Univ., Fac. of Sci. Journ.*, vol. 2, 1926, pp. 1-75), by Prof. A. Imamura (*Imp. Earthq. Inv. Com. Bull.*, vol. 10, 1928, pp. 71-107), and by Prof. N. Yamasaki (*Ibid.*, pp. 109-113). The epicentre lies to the east of Tuiyama Cove and close to the village of Tai. The focus must have been of considerable size in the vertical direction. From a study of the intensity distribution, Imamura concludes that its depth was about 6 miles, while Dr. K. Wadati, from the transmission curves of the $\bar{P}$ and P phases, estimates it at 20 miles. On the top of a hill near Tai, two faults were formed, each about a mile long, running north-east and south-west, roughly parallel to one another and to the old steep fault-scarps facing Tuiyama Cove. The greatest vertical throw was about 3 ft. 3 in., and the horizontal shift (of the west side towards the north) between 2 and 3 inches. The Tajima and Tango earthquakes occurred on the north side of the island, in what is known as the inner seismic zone, and within four years after the great Kwanto earthquake of 1923. Prof. Imamura notices that several other great movements in the east or outer seismic zone (in 1676, 1854, 1894, and 1896) were followed within a few months by others in the inner zone.

AN UPPER LIMIT TO ENERGY DENSITY.—In the September issue of the *Proceedings of the Physico-Mathematical Society of Japan*, Prof. S. Suzuki puts forward the hypothesis that there is a limit to the energy which can be concentrated in a given volume, just as on the theory of relativity there is a limit to the velocity a body can have. It would follow from such a hypothesis that as the energy density in an enclosure is proportional to the fourth power of the absolute temperature of the enclosure, there is an upper limit to temperature. Planck's radiation formula would require an additional term which becomes important for long waves and high temperatures. The frequency of a light quantum could not increase indefinitely, and the Compton increased frequency effect could not be produced when an extremely rapid electron struck a quantum of extremely high frequency.

ELECTRIC STARTERS FOR MOTOR-CARS.—Owners of motor-cars are chary of using their self-starters too often as they fear that the battery may lose too much of its charge. They will be interested, therefore, in a paper by Dr. Smith-Rose and Mr. Spilsbury on tests of electric starters for motor-cars, which is published in the *Journal of the Institution of Electrical Engineers* for January. The instantaneous values of the currents during starting were found by an oscillograph. The first car experimented on had a nominal 12 horse-power, 4 cylinder engine with a 12-volt battery. It was started by means of a dynamotor unit permanently connected to the engine shaft by a chain drive. The tests were made with the engines both hot and cold. Each of the other two cars had a separate starter motor unit, the driving pinion of which was only engaged with the engine fly wheel during the actual starting operation. In car No. 1, when the starter switch was first closed the current jumped up to a value of 195 amperes, the battery pressure rapidly falling from 12·4 to 9·3 volts; and then rising. In car No. 2, the current rushed up first to a peak value of 154 amperes and then to a second peak value of 228 amperes. With the third car they found a peak current of 260 amperes at the instant when the pinion and flywheel engaged. These large currents are of importance in practice, as they doubtless damage the battery by displacing paste from the plates. It seems likely that their value determines the life of the battery. It is satisfactory to find, however, that although the currents are so large the total quantity of electricity discharged from the battery during a normal starting operation is very small. The tests show that the engines started up from their cold condition in times varying from 0·39 to 0·75 of a second after pressing the switch. This corresponds to a total discharge varying from 63 to 128 coulombs. With the engines warm, they started in about half the time and used half the coulombs. It is concluded, therefore, that with a normal car there is little risk of the battery becoming discharged owing to frequent use of the starter.

CARBON SULPHIDOSELENIDE.—A new method of preparation of carbon sulphidoselenide, CSSe, together with an account of its properties, is described by H. V. A. Briscoe, J. B. Peel, and P. L. Robinson in the *Journal of the Chemical Society* for January. This compound was previously prepared by Stock and Willfroth by striking an arc between carbon poles containing selenium, under carbon disulphide, but the new method consists in passing carbon disulphide vapour over heated ferrous selenide, when a partial replacement of sulphur by selenium occurs. Carbon sulphidoselenide is a deep yellow liquid boiling at nearly 84° and having a density of 1·9874 at 20°. Its constitution, as deduced from surface tension measurements, appears to be Se = C = S, but it is less stable than carbon disulphide. Carbon sulphidoselenide has an unpleasant odour and is non-inflammable; its vapour is lachrymatory. It is immiscible with water, but soluble in most organic solvents. With phyenlhydrazine and aniline, carbon sulphidoselenide reacts in a manner analogous to carbon disulphide.

PHYSICO-CHEMICAL INVESTIGATIONS UPON RADIUM.—The increased demand for radium preparations for use in the cure of certain diseases has caused attention to be directed to the supplies available from the Belgian Congo. It has apparently been overlooked that the element was first discovered by Prof. and Mme. Curie in the pitchblende deposits of Jáchymov (St. Joachimsthal) in north-west Bohemia, where the isolation of radium products has been resumed since 1920. In the *Collection of Czechoslovak Chemical Communications* (January 1929), Prof. J. Heyrovský and S. Berezický describe the application of the dropping mercury cathode methods for determining the deposition potential of radium, which is found to be 1·718 volts. The deposition potential of the element in the presence of barium and other salts was also studied, using preparations containing amounts ranging from 14·6 per cent of radium to a preparation containing 97·3 per cent of radium chloride. It is found that the difference in the deposition potentials of the alkaline earth metals are great enough to permit of the deposition of each of them being followed in their mixtures. Traces of radium are noticeable in any amounts of calcium or strontium solutions, even in the presence of alkali metals. The deposition of radium becomes indistinguishable, however, when the ratio of barium to radium exceeds 10 : 1. Traces of barium are discernible in solutions of all the alkalis and alkaline earths. The application of the polarographic method with the dropping mercury cathode to the determination of the solubilities of sparingly soluble salts has also been found to give concordant and satisfactory results.

The British Industries Fair.

THE London section of the British Industries Fair, organised by the Department of Overseas Trade, was opened at the White City on Feb. 18; the Birmingham section, which was organised by the Chamber of Commerce under the auspices and with the support of the Department of Overseas Trade, being simultaneously opened at Castle Bromwich. Both sections will be open from Feb. 18 until Mar. 1 inclusive. Only British manufacturing firms were permitted to exhibit, and no exhibitor might exhibit articles other than those of his own manufacture.

The primary appeal of the Fair is to trade buyers, and in order to attract them a special advance overseas edition of the catalogue of the London section was issued early in January to 10,000 business men in Europe, North America, South Africa, and the eastern coast of South America, in time to enable buyers in cities so far apart as Constantinople, Cape Town, and Vancouver to receive a copy before commencing their voyage to England. The catalogue contains descriptions, though in little more than bare enumeration, of the exhibits of more than 1200 British manufactures, and embodies a complete classification of all those exhibits by trades, as well as indexes in nine languages, thus enabling foreign buyers easily to trace the goods in which they are particularly interested. As catalogues go, it is as clear as its conciseness will allow, but the authorities responsible for its publication might realise that its format, by the mere growth of its pages, is now become awkward. There are 400 pages constituting the body of the catalogue, with more than 260 pages of advertisements in addition. The size of the page being relatively small, the result is a paper-backed volume an inch thick which has to be so tightly pasted that it is difficult to open the catalogue widely enough to enable the beginning of the line to be read with ease.

No less than 39 trades (several of them being really groups of trades) are represented in the London section, from perambulators to pianofortes; but readers of NATURE will naturally be more interested in the scientific industries. An outstanding exhibit is that of the Imperial Chemical Industries, Ltd., that 'rationalised'—to use a term currently fashionable—embodiment of more than forty subsidiary and associated companies, operating throughout the British Empire and the world. This exhibit comprises heavy chemicals, explosives and ammunition, dyestuffs, metals and fertilisers, all of which are shown on a large site having for its central feature a cinema hall. Here films are shown continuously illustrating the manufacture of heavy chemicals, the making of dyestuffs, the use of blasting explosives (depicting the fall of 30,000 tons of limestone); and a film showing by examples the uses of fertilisers and their benefit to agriculture.

British optical and scientific instruments and photographic goods occupy nearly 8000 square feet. This section was inaugurated only in 1926, when there were 22 exhibitors, occupying 1700 square feet. This year there are 60 exhibitors occupying no less than 7662 square feet—a significant testimony to the rapid growth of these important branches of British industry. In view of the growing use of optical and scientific instruments for purposes of research, control, and test, in an ever widening and varied field of industrial processes, the exhibits in this section should grow more rapidly still if the manufacturers concerned realise the value of the opportunities that the Fair provides. A glance through the optical section shows that many of the leading British optical manufacturers, some of whom have deservedly a world-wide reputation, are represented, though there are also some not less notable omissions. It may be that for optical instrument manufacturers and also for the manufacturers of scientific instruments, in the stricter sense, the annual exhibition of the Physical and Optical Societies, held usually in January at the Imperial College of Science, South Kensington, provides a better *milieu* for appeal to the experts who can best judge of the value of such productions.

This view may account, in part at least, for the list of exhibitors in the optical and scientific instrument section of the British Industries Fair being less comprehensively representative than it might be. One can readily understand that the expenditure of time, energy, and money needed for the preparation of exhibits may easily constitute a serious financial burden on any firm, and more particularly on the comparatively small industrial units engaged in the optical and scientific instrument industries, if there should be an undesirable increase in exhibitions. But the British Industries Fair, with its wide range of appeal to trade buyers from the four corners of the earth, should provide a very suitable opportunity for display complementary to that provided by the annual exhibition of the Physical and Optical Societies.

The pre-eminence of British optical and scientific instruments in certain lines is unquestioned; but there are certain types of optical and instrument products in which the legend still lingers that particular foreign products are the best, even though recent improvements in the corresponding British productions may have falsified the legend. The British Scientific Instrument Research Association, for example, has recently published the results of a prolonged investigation into the characteristics of some typical British and foreign ammeters and voltmeters of the switchboard pattern. One upshot of that investigation is the definite conclusion that "the best-known British instruments of the kind dealt with are quite equal to the best-known corresponding products of foreign origin, in the suitability of their design for the purpose to be served, in the consistency of their indications, and in the general lines and details of their construction."

Among the conspicuous features of the exhibits of British optical and scientific instruments and photographic goods, the following may be mentioned: Ultra-violet ray equipment, embodying automatic control of the time of exposure; daylight lamps which, it is claimed, give the same effective results as before with the use of considerably less current; compasses suitable for fast motor-boats and a depth-sounding device for use at full speed; inter-communication telephones for use on aeroplanes or ships where noise makes the use of ordinary instruments impossible; a new splinter-proof glass for spectacles; the colour 'snap shot'—the special film which makes it possible to take colour 'snap shots' with an ordinary camera; a roll-film reflex camera for speeds up to 1/5000th of a second; and a photographic plate with a speed of '2000 *H* and *D*,' to use the appropriate technical term—four times as rapid, it is said, as any plate previously produced.

Scientific exhibitors, actual or potential, should also realise that, apart from the direct benefits in the shape of trade orders that are likely to accrue from the exhibition, the display of a representative and fairly comprehensive collection of optical and scientific instrument exhibits in a Fair organised by a department of Government may also have its indirect benefit in assisting Government to realise the value and importance, from a national viewpoint, of these particular industries.

The Paulin Aneroid.

THE Swedish engineer, G. Paulin, has recently applied the null reading principle to the aneroid barometer. The action of the instrument will readily be understood from the illustration (Fig. 1). The diaphragm *a*, the total range of motion of which is restricted by means of stops to about $\frac{1}{40}$ mm., actuates the frame *j*, to the upper ends of which are attached phosphor bronze strips, bent at an angle and fastened at their lower ends to the base. To the angles of the

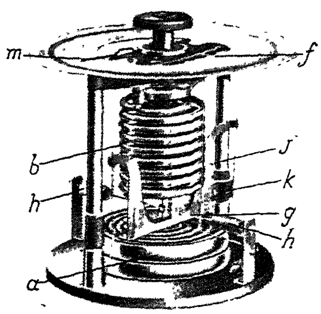


FIG. 1.

latter strips are attached two horizontal strips *k*, which are pinned above and below a transverse torsion strip *g*, held by springs *h*, and carrying the *null* pointer *f*. It will be seen that a rise or fall of the diaphragm alters the angles of the bent strips and imparts a twist to the torsion strip *g* through the horizontal strips *k*.

The *scale* pointer *m* is carried by a central threaded spindle, passing through a nut attached to the upper end of the spiral spring *b*. The lower end of this spring is coupled to the diaphragm. Varying air pressure on the diaphragm is thus equilibrated, and the diaphragm thereby restored to its null position by the measured rotation of the central spindle.

The writer has recently had an opportunity of testing this type of barometer on an experimental survey in the Eastern Highlands of Scotland, in the course of which checks on the aneroid readings were obtained at frequent intervals by means of trigonometrically fixed heights. Normal surveying practice was followed by reading a stationary barometer at intervals during the field traverses to allow for diurnal and weather changes of pressure, and the effect of varying temperature of the air column was allowed for, on the usual isothermal assumption, in reducing the field readings.

The makers claim that friction errors are eliminated, and this claim would appear to be substantiated. The reading is always consistently definite and is not affected by tapping.

The extent of the first climb in the early morning was invariably *exaggerated* by the instrument to the order of $1\frac{1}{2}$ per cent. This error is not due to hysteresis, since it is in the wrong sense. Neither is it due to want of sympathy between the makers' graduation formula and the local meteorological and geographical conditions, for an independent computation from the International formula reveals no greater difference on this score than 0·1 per cent. The only alternative which suggests itself is faulty temperature compensation of the particular instruments under trial. Temperature fell considerably during the climb, and it is likely that insufficient time was allowed before starting to enable the traverse barometer to take up the outdoor temperature. It is indeed difficult to see how the mechanism described in the makers' catalogue can be compensated. On the other hand, the writer has been shown the results of National Physical Laboratory tests on other barometers of this type, which indicate remarkably good temperature compensation. Possibly the difficulty has been overcome in later models, at any rate in selected specimens.

Minor variations in altitude were recorded to within one or two feet of truth, and in all cases where the temperature remained sensibly constant the traverse closed to within two or three feet, even after a sudden drop of a thousand feet.

This instrument would appear to mark a step forward in the design of surveying barometers, although more extended field trials are necessary before this can be stated with assurance. M. H.

Isostasy.

By GEORGE R. PUTNAM, U.S. Department of Commerce, Washington, D.C.

THE condition of equilibrium in the crust of the earth is maintained by under-surface compensation of some sort, between the extremes of no compensation (a rigid crust) and complete local compensation (a plastic crust). Common knowledge shows that the materials of the crust are too weak for rigid support of the relief, and are too strong for complete local isostasy. What, then, is the most probable arrangement of the actual isostatic compensation ?

Gravity measurements furnish the principal evidence. Of the methods for their discussion, the reductions of Bouguer and Hayford correspond to the above two extremes. The large Bouguer anomalies prove that the crust is not rigid. In papers printed in the May 1928 issue of the *Proceedings of the National Academy of Sciences*, I have shown that the Hayford hypothesis of complete local compensation is untenable, and leads to significant error.

The Hayford method assumes that the isostatic compensation is "complete under every separate portion of the earth's surface," however small. This hypothesis was not claimed to be completely true, but this notable work has been built around local compensation, as complete as mathematically practicable. Hayford and Bowie allude to any error due to this assumption as a negligible matter. The Hayford reduction divides the area about the station into very small compartments, and assumes complete local compensation for each. The first zone is a cylindrical column 2 metres in radius and extending downward 113,700 metres (71 miles), and this column is assumed to be in perfect equilibrium, free to move without resistance from surrounding materials. This cannot represent a condition possible in Nature. Such compensation could be true only with materials wholly plastic, and no remaining surface relief.

The errors in the Hayford residuals show as over-compensation for stations above the average level, and as under-compensation for stations below ; they are appreciable or large for mountainous stations, but negligible in fairly level regions. They are similar to the 'free air' reduction errors, although much smaller. The proofs given depend mainly on comparisons of pairs of adjacent gravity stations differing materially in elevation. The evidence shows that regional compensation cannot be ignored in gravity reductions.

I also used this strong method by pairs, for a measure of the horizontal extent of regional compensation, and find evidence that this is appreciable to about 160 kilometres (100 miles) from the station.

Another basic hypothesis of the Hayford reduction is that the densities so vary with the elevation that the mass in a unit column is constant. This cannot be true even approximately, in mountainous regions, for small unit areas. The correct conception is that of limited regional compensation horizontally, which is the same as incomplete compensation vertically, or partial lack of local compensation, for features of moderate extent.

All this affects the discussion of the so-called Airy and Pratt theories. With regional isostasy there will be horizontally extended compensation beneath mountains, instead of individual downward protuberances. Probably the depth of compensation varies appreciably, and the topographic relief must be explained by more than one kind and direction of force.

To bring the gravity measurements within the possibility of mathematical treatment general assumptions cannot be avoided, but these must be physically reasonable, and be such as to result in minimum residuals.

In the papers to which reference has been made, two regional isostatic methods of reduction of gravity observations are given. One, a more accurate method now first proposed, uses a practicable regional system of reduction by averaging the elevation for moderate areas about the station, thus avoiding the local compensation error. It yields results nearer the truth than the Hayford method, and requires less labour. A more correct, but less readily computable, conception, would substitute a warped surface for a levelled area about the station.

The second method, the 'average elevation isostatic reduction,' was devised and used by me in 1895; it averages the surface elevation within 100 miles of the station, and applies a compensation for this average elevation. This is a simple method, although approximate, as it neglects curvature. On a reasonable conception of isostasy, it eliminates or greatly reduces the extreme residuals in mountainous regions. This method is of special significance in the general problem, as it proves isostasy without using the Hayford assumptions. It is not based on any assumption as to the thickness or vertical density arrangement of the compensation, providing it is at a considerable depth, and hence an unlimited number of combinations of these elements will satisfy the condition of isostasy. This reduction is a regional treatment of compensation, and the area used conforms well to that found, by more exact methods, to be regionally compensated. It confirms the previous conclusion that regional isostasy cannot be ignored.

In 1894, gravity measurements across North America were made by me for the Coast and Geodetic Survey, at stations which had been carefully selected to test the condition of the earth's crust. I applied this average elevation reduction to these and other determinations, representing extreme and diversified conditions. This work, on a basis of isostasy, eliminated the larger residuals which all preceding methods had failed to do, and it was the first consistent proof of isostasy.

The first observational evidence of crustal equilibrium came from British trigonometric and gravimetric surveys in India. The first definite proposal of this theory was made by Airy seventy-three years ago, and English scientists have continued to make valuable contributions to the theory of isostasy.

University and Educational Intelligence.

CAMBRIDGE.—The governing body of Emmanuel College offers to a research student commencing residence at the University in October next, a studentship of the annual value of £150, tenable for two years. Preference will be given to a candidate who has already completed at least one but not more than two years of research. Applications should reach the Master of Emmanuel (The Master's Lodge, Emmanuel College, Cambridge, England) not later than June 30.

THE Geological Department of the University of Melbourne has been provided with a new building at the cost of £21,000, by a grant from the Government of Victoria. On the occasion of the opening of the new building by Lord Somers, the Governor of Victoria, a pamphlet has been issued summarising the history of the Department and giving a list of positions obtained by its graduates, and of the 123 papers issued in connexion with the School during the past twenty-three years. The pamphlet refers to the early history of the school under its founder, Sir Frederick McCoy, from 1854 until 1899, Prof. Gregory during the next five years, and Prof. Skeats since 1904. It has been conducted in recent years in a joint building with metallurgy erected in 1905. The growth in the number of students has rendered necessary the provision of the present large and well-equipped building. The staff of the Department includes Dr. Summers as associate professor and Mr. Frederick Chapman, of the Victorian National Museum and now acting as Palæontologist to the Australian Federal Government, as lecturer in palæontology.

STUDLEY COLLEGE, Warwickshire, is appealing to the public, and especially to those having agricultural interests, for £20,000 to enable it to continue its work of providing courses of instruction for women in horticulture, agriculture, dairying, and poultry-husbandry. Originating as a hostel at Reading in 1898, the College moved in 1903 to Warwickshire, where it became a teaching centre for gardening and dairying. It now provides a three-years' diploma course in horticulture; two-years' courses in horticulture, in agriculture, in dairying, and in poultry-husbandry; one-year and shorter courses in the above subjects and instruction in carpentry, bee-keeping, fruit-bottling, and floral decoration. The fees for tuition and residence amount to 110 guineas and upwards per annum. The College is always full, and the demand made upon it for trained workers is greater than it can supply with its present accommodation, which is limited to sixty resident students. Of the twelve hundred women who have passed out from it, many are now managing their own land or earning salaries not only in Great Britain but also in Australia, New Zealand, Uganda, Kenya, South Africa, Canada, India, and Ceylon, where they are growing crops of all kinds, including cotton, lemons, oranges, coffee, and tobacco. In 1911 the College obtained a lease of Studley Castle estate, comprising the castle, farm buildings (now needing repair and enlargement), and 340 acres of land. This lease is now drawing to a close and £15,000 must be raised before July 1 to complete the purchase of the freehold. Towards this the Treasury has promised a grant of £5000, former students have pledged themselves to find £1000, and the present students and staff are contributing £300. The College is recognised by the Ministry of Agriculture and Fisheries, from which it receives an annual grant of £1000. The appeal is signed by the Marchioness of Londonderry as president. Donations may be sent to the honorary treasurer, Mr. H. Keeling, 26 Eccleston Street, London, S.W.1.

Calendar of Patent Records.

February 26, 1781.—The pigment known as 'Turner's Yellow' or 'Patent Yellow' was the subject of a patent granted to James Turner on Feb. 26, 1781, and was at one time extensively used. The validity of the patent was twice upheld in the courts and its life was extended by Act of Parliament (32 Geo. 3, c. 73) on the ground that "the colour was made from British materials, and that the invention has not only in a great measure superseded the necessity of importing the colour from abroad, but it is now exported in considerable quantities to most parts of Europe, the East and West Indies, and America, . . . and by the great consumption of common salt necessarily used in preparing the same the said invention will afford an increase to the public revenue." Like most lead paints, however, 'Turner's Yellow' is affected by long exposure to a sulphurous atmosphere, and the introduction of the chrome colours has rendered it obsolete.

February 27, 1802.—The closed kitchen cooking-range was first patented by George Bodley, of Quay Foundry, Exeter, on Feb. 27, 1802. The patent was for a stove constructed with an oven on one side and a boiler on the other, the flue gases passing from the upper part of the stove round three sides of the oven, under and up one side of the boiler, and then into the chimney; the whole being covered with a plate upon which vessels could be warmed.

February 28, 1799.—The so-called American type of windmill, in which instead of the small number of sails of large size, common to the mills of Europe, there is a large number of small blades arranged in wheel formation, was included in an English patent granted to George Medhurst on Feb. 28, 1799.

February 29, 1612.—The patent granted to Simon Sturtevant on Feb. 29, 1612, for the use of coal in all metallurgical operations, including iron production, was surrendered the following year, and it is chiefly of interest now because in it Sturtevant foreshadowed with remarkable accuracy the procedure, adopted officially much later, of filing provisional and complete specifications in connexion with patent applications. Sturtevant not only annexed to his petition for a patent a statement describing "in some measure" his invention and the method of carrying it out, but he declared also that the invention would be "more fully, amply, and particularly demonstrated, specified, described, and contained, in a large treatise which shall be put in print and published before the last day of Easter term next," and the treatise was in fact published by the date mentioned. The specification did not become a regular feature of the procedure of patent practice until more than a hundred years later, and the filing with the application of a provisional specification describing the nature of the invention was especially adopted by the Act of 1852.

March 1, 1651.—The official series of English and British patents which begins with the year 1617 and is being continued to-day, does not include any entries for the Commonwealth period, though several patents were granted during that regime. Some of these were in the usual way by Cromwell's Letters Patent, but others were granted direct by Act of Parliament and not under the Great Seal. One of these latter was to Jeremy Buck, of Minchinhampton, Glos., and dates from Mar. 1, 1651. Like Sturtevant's referred to above, it is one of the many unsuccessful patents dealing with the use of coal for smelting iron. The Act contains a proviso that, after seven years, Buck was to take apprentices and "teach them the knowledge and mystery of the new invention."

Societies and Academies.

LONDON.

Geological Society, Jan. 23.—**J. K. Charlesworth**: The South Wales end-moraine. The Irish Sea ice stood over Cardigan Bay at the period of the maximum advance of the Newer Drift period, and ponded back the natural drainage of northern Pembrokeshire and southern Cardiganshire to form a chain of extra-glacial lakes connected by marginal streams. The end-moraine of the Newer Drift passes across eastern and southern Wales. In northern Pembrokeshire and southern Cardiganshire it was laid down along the edge of the Irish Sea ice. Farther east, the moraine is practically continuous, and represents the marginal product of the local Welsh ice, which was centred in the mountains of Central Wales, the Carmarthenshire Vans, the Brecon Beacons, the Black Mountains, and the mountains of Radnor Forest. This ice flowed beyond the outlets of the great valleys of the east to form the valley-glaciers of the Severn and other rivers, and extended southwards on to the coastal plain of Glamorgan. The Newer Drift is of early Magdalenian age.—**A. Jowett** and **J. K. Charlesworth**: The glacial geology of the Derbyshire dome and the western slopes of the Southern Pennines. The Derbyshire Dome of the Southern Pennines was over-ridden at the period of maximum glaciation by ice from the north and north-west. This is shown by the occurrence of patches of true boulder clay, by the wide distribution of erratics of Lake District and Galloway rocks over the dome and along its valleys, and other evidence. The upper limit of the erratics from the north follows the outer flanks of the south-western Pennines at about 1250 feet above sea-level. The ice-recession from this position was associated with a copious marginal drainage, which eroded a well-developed suite of channels linking a number of big extra-glacial lakes in the valleys of the western Pennines.

Physical Society, Jan. 25.—**C. Vernon Boys**: A fused quartz pendulum rod for clocks. Possible causes of the progressively increasing losing-rate found in the going of the Shortt clock are discussed. A design is given for the free pendulum with rod of fused quartz; carbon steel and mild steel for the supporting springs and the bob respectively are suggested.—**G. W. Sutton**: A method for the determination of the equivalent resistance of air-condensers at high frequencies. The losses in air-condensers are divided into two portions: (*a*) those due to leakage through the solid dielectric, and (*b*) those due to terminal and plate resistance. A method is developed for measuring each, under conditions such that the other is negligibly small.—**L. Hartshorn**: The measurement of the anode circuit impedances and mutual conductances of thermionic valves. A Wheatstone bridge method with current of telephonic frequency is used. Although both anode circuit resistance and mutual conductance vary very considerably with the grid bias, the product of the two, which gives the voltage factor of the valve, is approximately constant. The increase in the effective values of the inter-electrode capacities is explained by the presence of the space charge, which also has the effects of making these capacities vary with the frequency and of giving them a comparatively high power factor, especially at low frequencies.

Linnean Society, Jan. 31.—**Miss G. H. Faulkner**: The anatomy and histology of bud-formation in the Serpulid, *Filograna implexa*. The genus *Salmacina* is synonymous with *Filograna*. The position of the plane of fission and the initial size of the bud are

variable, both being related to the length of abdomen of the stock. Internal histological changes accompany the formation of the external form of the bud. These result in a complete histolysis of the original tissues of the bud-segments and their replacement by embryonic cells.—**R. W. G Hingston**: The natural history of the Oxford University Expedition to Greenland in 1928. Godthaab was selected as the place for investigations. Animal life is abundant, but the proportion of individuals to species is small. The birds are more prolific than the corresponding species in temperate regions and their development is more rapid. The Passerine birds laid on an average two more eggs in each clutch, and the fledgling periods were reduced by five or six days. The Polar wolf and hare do not change into a brown coat in summer, because in summer, owing to the superfluity of food, there is no struggle for existence in the ordinary sense, and therefore no necessity for such change.

Paris.

Academy of Sciences, Jan. 21.—The president announced the deaths of M. Widal, member of the Section of Medicine and Surgery, and M. Riquier, *correspondant* of the Section of Geometry.—**A. Lacroix**: The chemical composition of the tectites, and in particular of those of Cambodia.—**Eduard Čech**: Projective deformation of plane networks.—**Paul Delens**: Systems of two circles and groups of spherical operations.—**L. Lusternik** and **L. Schnirelmann**: A topological principle in analysis.—**K. Kunugui**: The infinite and minimum type of dimension.—**Krawtchouk**: A theorem of Laguerre.—**Henri Cartan**: A new theorem of unicity relative to meromorph functions.—**J. Herbrand**: The non-contradiction of the arithmetical axioms.—**W. Margoulis**: The experimental determination of the tensions in the frames of aeroplanes.—**J. Haag**: The influence of the inertia of the spiral on the rate of chronometers.—**Joseph Pérès**: The action of an obstacle on a viscous fluid; a simple demonstration of the formulæ of Faxén.—**J. E. Verschaffelt**: The equation of van der Waals and thermodynamics. Discussion of a recent communication on the same subject by V. Karpen.—**C. Raveau**: The principle enunciated by Carnot: the theorem. The formulæ of the second domain of thermodynamics independent of any principle.—**B. Decaux**: The calibration of tuning-forks serving as a basis for the measurement of radiotelegraphic frequencies. The method described permits of an accuracy of 3 in 100,000.—**V. Dolejšek** and **Mlle. D. Engelmannová**: The spark doublets in the K series.—**J. Gilles**: The structure of the third order spectrum of sulphur.—**H. Volkringer**: The continuous spectrum of mercury vapour.—**Pierre Bricout**: A spectrograph objective possessing a focal distance constant to a thousandth approximately between 1850 A. and 7000 A. The elements of a quartz-fluorspar doublet are separated by a thin convergent meniscus of distilled water. This gives an objective remarkably achromatic over the range of spectra for which a quartz-fluorspar lens is commonly employed.—**R. Coustal**: The realisation of a phosphorometer by means of which measurements of the intensities of phosphorescence can be rapidly carried out.—**B. Bogitch**: A method for the electrolysis of nickel. A description of an industrial method for preparing nickel electrolytically of 99·9 per cent purity from a nickel containing 10 per cent of impurities. The electrolytic solution is a strong solution of nickel chloride heated to 65° C., the anode and cathode compartments are separated by a diaphragm, and fine nickel wires are used as the cathode.—**Mlle. Suzanne Veil**: The chromites and ferrites of nickel and cobalt.—**Octave Mengel**: The presence on the south slope of the Pyrenees of overthrust elements proceeding from a fold in the north.—**Robert Perret** and **Léon Moret**: The limits of the Bathonian in the Sixt Alps (Haute Savoie).—**H. Baulig**: The forms of relief in the central plateau of France and its Mediterranean border: general results.—**P. Mazé**: The determination of the temperature of the chloroleucites in maize plants exposed to the sun.—**A. Perrier**: The transformations of chlorophyll in a green alga.—**Max** and **Michel Polonovski**: The aminoxides of hydrastine and of narcotine. Hydrastine and narcotine oxidised with hydrogen peroxide give true N-oxides: these are unstable, and are easily transformed into compounds the nature of which is still under investigation.—**C. Vaney** and **A. Bonnet**: The phenomena of regeneration in *Spirographis Spallanzanii*.—**Aversenq, Jaloustre,** and **Maurin**: The action of thorium-X on the proportion of active principles of certain medicinal plants. Experiments are given showing that radioactivity is capable of producing a marked increase in the proportion of active principles of certain plants.—**J. André Thomas**: The rôle of the grouping of individuals in the perturbations of tropisms of *Convoluta Roscoffensis* by some alkaloids.—**L. Hugounenq** and **E. Couture**: The action exercised on the photographic plate by cholesterol extracted from cod-liver oil. Cholesterol extracted from bile calculi, or from ox brain, has no action, even after several days' exposure, on a sensitive photographic plate. Cholesterol extracted from cod-liver oil, on the other hand, exposed on the same plates under similar conditions, causes the appearance of well-marked black spots.—**S. Mutermilch** and **Mlle. E. Salamon**: The vaccination of the rabbit against cerebral tetanus.—**P. Descombey**: The antitetanus immunisation of the guinea-pig by the intracerebral injection of tetanus anatoxin.—**L. Normet**: The treatment of experimental hæmorrhage in the dog by an artificial serum containing citrates.

Rome.

Royal National Academy of the Lincei: Communications received during the vacation.—**G. Fubini**: The transformations of Laplace, Lévy, and Moutard for hyper-surfaces.—**F. Zambonini** and **V. Caglioti**: The quantitative spectroscopic determination of small quantities of strontium, barium, and cæsium in minerals, rocks, natural waters, etc. The method long in use for the determination of lithium and consisting in ascertaining at what dilution the characteristic red line of the spectrum just disappears, is applied to strontium, barium, and cæsium. For the first two of these metals, the method requires absence of free acid from the solutions. The presence of barium does not influence the spectroscopic determination of strontium, but calcium in marked quantity renders the results less exact. Neither rubidium nor lithium affects the results obtained with cæsium, but if potassium is present in large proportion, the solution used for comparison should contain potassium in similar proportion. Under such conditions, the method gives approximately exact results with materials containing as much as 10 per cent of cæsium.—**G. Aliprandi**: The principal normals (according to Vitali) of a generic surface of Hilbertian space.—**Silvia Martis in Biddau**: The exponentials of matrices of the second order and their application to the theory of groups.—**G. Sansone**: The equation which satisfies the coefficient a of the congruence $x^3+ax+a\equiv 0$ (mod. p) with p prime.—**R. Calapso**: A new transformation of isothermal surfaces. With the help of the ready transformation of the R-surface of Tzitzéica into an isothermal

surface of a four-dimensional space, it was recently shown that the projective deformation of an R-surface is reducible to a transformation C_m. A new transformation of the isothermal surface, of which that of Darboux is a particular case, is now established.—**G. Colonnetti**: New contribution to the theory of elastic co-actions and its technical applications (3). The theorem enunciated and demonstrated in the two previous notes is applied to the solution of certain concrete problems of technical interest.—**H. Geppert**: Adiabatic invariants of a differential generic system (3). The differential systems of two dimensions having been considered in the earlier notes, the more general case of the generic system of n dimensions is now discussed.—**A. Masotti**: A form of the dynamic equations of a system of rectilinear vortices.—**A. Belluigi**: Gravity measurements and isostasy.—**A. Ferrari** and **M. Carugati**: The importance of the crystalline form in the formation of solid solutions (4). Thermal analysis of the anhydrous systems $MgCl_2 - FeCl_2$ and $CdCl_2 - FeCl_2$. As would be expected from the similarity in crystalline structure of their components, each of these two systems exhibits complete miscibility in the solid state.—**E. Pace**: Pinacones and pinacolines. It has been previously shown that the action of organo-magnesium compounds on γ-diketones gives rise to ditertiary glycols, which can be readily transformed into heterocyclic derivatives of tetrahydrofuran, tetrahydropyrrole, and tetrahydrothiophen. Similarly the α-diketone diacetyl reacts with two molecules of magnesium alkyl halide, yielding α-ditertiary alcohols (pinacones) which may be converted into the corresponding pinacolines by dehydration with dilute sulphuric acid and subsequent distillation in a current of steam. Acetylacetone, the most important of the β-diketones, fails, however, to react with magnesium alkyl halides, due perhaps to the existence of acetylacetone as an equilibrated mixture of desmotropic forms.—**L. Settimj**: Chemical composition of certain food pastes and the modifications effected by boiling in water. In materials of the macaroni type, the starch granules are mostly somewhat distorted and in some cases exhibit deep fissures, the central hilum being always shown as a point. After being boiled the granules are larger, the few that remain intact presenting undulating contours; the interior of the granules shows stratification and the central hilum resembles a vacuole. The boiled substance contains about 20 per cent of soluble starch and 6 per cent of reducing sugars, and shows a marked diminution in the proportion of soluble nitrogenous materials.—**P. Di Mattei** and **F. Dulzetto**: Histochemical demonstration of glutathione and its distribution in certain organs. To detect glutathione, the organs are reduced to small fragments and immersed for at least thirty minutes in 20 per cent trichloroacetic acid solution immediately after removal from the animal. Sections 4-5 μ in thickness are cut by the freezing method, placed on microscope slides, and treated for 3-4 minutes with freshly prepared 5 per cent sodium nitroprusside solution. The excess of the reagent being removed by means of filter-paper, the slide is inverted over the open mouth of a bottle of concentrated ammonia solution. An amaranth red coloration, appearing at once, indicates the location of the glutathione.—**E. Caroli**: The microniscus phase of *Ione thoracica* (Montagu) obtained by culture on copepods.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 14, No. 11, Nov. 15).—**Harlow Shapley**: Studies of the galactic centre. (1) The programme for Milky Way variable stars. Five years ago an observing programme was arranged at Harvard Observatory to provide material for the general study of faint variables as bearing on the Milky Way problem. The observations will be continued for another five or ten years and the results summarised under the above general title. The problem is largely one of the improvement and extension of existing standards of magnitude.—**Harlow Shapley** and **Henrietta H. Swope**: Studies of the galactic centre. (2) Preliminary indication of a massive galactic nucleus. Examination of the distribution with respect to median magnitude of twenty-six cluster type variables in the field to the north of Ophiuchus and Scorpio, suggests a nucleus at a distance of nearly fifty thousand light-years, which agrees with the distance of the galactic centre as determined from measurements of the globular clusters.—**Gustaf Strömberg**: The determination of absolute magnitude dispersion with application to giant M-stars.—**Arthur E. Kennelly**: Gudermannian complex angles. These functions have many applications in physics and electrical engineering. An outline table of complex gudermannians is given.—**Nicholas A. Milas**: New studies in polymerisation. (1) Polymerisation of styrene. Benzoperacid increases the rate of absorption of oxygen in the initial stages of the oxidation of styrene and also the rate of polymerisation. Anthracene inhibits polymerisation and also the oxidation of the benzaldehyde formed. Yet in the presence of anthracene, oxidation of styrene proceeds at a relatively high rate, indicating selective inhibition. Polymerisation seems to be effected by energy liberated by the initial products of oxidation reacting with unoxidised styrene molecules.—**John R. Bates**: The quenching of cadmium resonance radiation. Hydrogen quenches the resonance radiation, probably having its vibrational energy increased.—**H. C. Sherman** and **H. L. Campbell**: The influence of food upon longevity. Using two diets, one of which, as shown by rates of growth and reproduction, is adequate, but the other is better, it is shown that the average duration of life of rats on the latter diet was almost ten per cent greater than those on the former diet.—**Carl Barus**: The interferometer **U**-gauge with closed auxiliary reservoirs.—**F. S. Brackett**: Characteristic differentiation in the spectra of saturated hydrocarbons. The vibration spectra in the near infra-red were examined. These give data as to the relative binding forces exerted upon the hydrogens when attached to primary, secondary, and tertiary carbons.—**E. O. Wollan**: Are characteristic X-rays polarised? Using a method based on integrated intensity measurements, it is found that, within the limits of experimental error, the $K\alpha$ lines of molybdenum are not polarised.—**J. G. Winans** and **E. C. G. Stueckelberg**: The origin of the continuous spectrum of the hydrogen molecule. A theoretical discussion.—**E. U. Condon** and **H. D. Smyth**: The critical potentials of molecular hydrogen. An examination of the experimental data on the lines of the preceding paper.—**Jesse W. M. DuMond**: The structure of the Compton shifted line. Theory predicts that the shifted 'line' is a diffuse band. Using scattering angles of 170°-178°, good agreement between observed and calculated structure was observed for scattering by aluminium, but additional lines appear with beryllium.—**Stanley Smith**: Some multiplets of doubly ionised lead.—**Benedict Cassen**: Spectral intensities of radiation from non-harmonic and aperiodic systems.—**Joseph Kaplan**: The aurora red line. In experiments on the excitation of the auroral green line when oxygen is mixed with active nitrogen, a red line is observed. This 'line' seems to be a

band belonging to the first positive group of nitrogen.—Ernest Merritt and William E. Bostwick: A visual method of observing the influence of atmospheric conditions on radio reception. Partial separation of the effects of the direct and the 'reflected' waves is achieved by using two balanced receivers, one with its plane vertical and directed towards the sending station, and the other in the vertical plane and at right angles to this direction. The coils are coupled with a local oscillator and made to actuate a cathode ray oscilloscope. The vertical and horizontal movements of the oscilloscope spot correspond in amplitude and phase with the oscillations received by the two coils.—Francis D. Murnaghan: On the energy of deformation of an elastic solid.—Raymond R. Willoughby: The survival of intelligence.

Official Publications Received.

BRITISH.

Royal Society of Arts, John Street, Adelphi, London, W.C.2. Cantor Lectures on Fatigue Phenomena, with Special Reference to Single Crystals: delivered before the Royal Society of Arts during February 1928. By Dr. Herbert John Gough. Pp. 108. (London.) 3s.

Indian Journal of Physics, Vol. 3, Part 2; and Proceedings of the Indian Association for the Cultivation of Science, Vol. 12, Part 2. Conducted by Prof. C. V. Raman. Pp. 151-305. (Calcutta.) 3 rupees; 4s.

Annals of the (Mededelingen van het) Transvaal Museum. Vol. 12, Part 4, December 29. Pp. 289-382. (Cambridge: Printed at the University Press.)

Canterbury College (University of New Zealand.) Records of the Canterbury Museum. Vol. 3, No. 3. Pp. 151-229+plates 24-37. (Christchurch, N.Z.)

Journal of the Indian Institute of Science Vol. 11A, Part 12: A Biochemical Study of some Soil Fungi with Special Reference to Ammonia Production. By A. K. Thakur and Roland V. Norris. Pp. 141-160. 1 rupee. Vol. 11A, Part 13: The Atomic Weight of Antimony from different Sources. By K. R. Krishnaswami. Pp. 161-172. 1 rupee. (Bangalore.)

Proceedings of the University of Durham Philosophical Society. Vol. 8, Part 1, 1927-1928 Pp. iv+69+xi. (Durham.) 5s.

Calalogue of the Nineteenth Annual Exhibition of Electrical, Optical and other Physical Apparatus, January 8, 9 and 10, 1929. Pp. 142+xxvi. (London: Imperial College of Science.)

Transactions of the Mining and Geological Institute of India. Vol. 23, Part 1, November. Pp. 90+vi. (Calcutta.) To Members, 2.8 rupees; to non-Members, 4 rupees.

Transactions of the Norfolk and Norwich Naturalists' Society. Presented to Members for 1927-28 Vol. 12, Part 4. Pp. xvi+383-526. (Norwich.) 10s.

University College of Wales, Aberystwyth: Welsh Plant Breeding Station. *The Effect of Nitrate of Soda on the Yield and Chemical* Composition of a simple Seeds Mixture in the First Harvest Year By T. W. Fagan, W E. J. Milton and Dr. A. L Provan. (Series H, No. 9, Seasons 1926-1927.) Pp. 27+10 Tables. (Aberystwyth.) 3s. 6d.

Proceedings of the Liverpool Geological Society. Session the Sixty-ninth, 1927-1928. Edited by C. B. Travis Part 1, Vol. 15. Pp. xvi+109. (Liverpool.)

The Bulletin of the Hill Museum: a Magazine of Lepidopterology. Issued at the Hill Museum, Wormley, Witley, Surrey. Vol 2, No, 1, February 8th. Pp. 100+1 plate. 15s. Vol 2, No. 2, June 18th. Pp. 101-182+22+4 plates. 15s. Vol. 2, No, 3, November 17th. Pp 183-270+23-44+3 plates. 15s Vol. 2, No. 4, Index. Pp. 271-296+vii. (London: John Bale, Sons and Danielsson, Ltd.)

The Ramblers' Federation Handbook: being the Official Year-Book of the Ramblers' Federation (Manchester and District) for 1929. Pp. 80+9 plates. (Manchester.) 1s. net.

Transactions of the Optical Society. Vol. 29, No. 5, 1927-28. Pp. 197-260+xv. (London) 10s.

Torquay Natural History Society Transactions and Proceedings for the Year 1927-8. Vol. 5, Part 2. Pp. 81-174. (Torquay.)

The Marine Biological Station at Port Erin: being the Forty-second Annual Report of the former Liverpool Marine Biology Committee, now the Oceanography Department of the University of Liverpool. Drawn up by Prof. Jas. Johnstone. Pp. 30. (Liverpool.) 1s. 6d. net.

Proceedings of the Royal Society of Victoria. Vol. 41 (New Series), Part 1. Pp. iv+62+11 plates. (Melbourne.)

Board of Trade. Second Report of National Fuel and Power Committee. (Cmd. 3252.) Pp. 46. (London: H.M. Stationery Office.) 9d. net.

The Oxford Preservation Trust. Second Annual Report, 1927-1928. Pp. 28. (London.)

FOREIGN.

University of Illinois Engineering Experiment Station. Bulletin No. 187: The Surface Tension of Molten Metals. Part 2: A Determination of the Capillary Constant of Silver. By Earl E. Libman. Pp. 22. (Urbana, Ill.) 15 cents.

Société des Nations: Institut international de Cooperation intellectuelle. Bulletin des relations scientifiques. 3e annee, No. 4, décembre. Pp iv+167-224. 8 francs. Index pour les années 1926 et 1927 (Nos. 1-6) Pp. 28. Index pour l'année 1928 (Nos 7-10). Pp. 18. (*Paris: Les* Presses universitaires de France.)

The China Foundation for the Promotion of Education and Culture: Social Research Department. Second Annual Report. Pp. 8. (Peiping.)

Proceedings of the Imperial Academy. Vol. 4, No. 9, November. Pp. xxxi-xxxii+513-568. (Tokyo)

China Foundation for the Promotion of Education and Culture. Factory Workers in Tangku. By Sung-Ho Lin. Pp. xi+128+8 plates. (Peiping.) 1 dollar.

The Carnegie Foundation for the Advancement of Teaching. Bulletin No. 22: A Retirement Plan for Colorado Public Schools; a Study made at the Request of the Colorado Education Association and the State Department of Public Instruction. By Howard J Savage and Edmund S. Cogswell. Pp. x+72. (New York City)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No 81 Seasonal Variation in Salinity of Nile Water in the Aswan Reservoir and at Rodah (Giza). By R Aladjem. Pp. 14+5 plates. (Cairo Government Publications Office) 5 P.T.

Department of the Interior: U S. Geological Survey. Bulletin 806-A: The Pumpkin Buttes Coal Field, Wyoming. By C. H. Wedgemann, R. W. Howell and C E. Dobbin (Contributions to Economic Geology, 1928, Part 2) Pp ii+14+5 plates. 10 cents. Water-Supply Paper 591: Surface Water Supply of the United States, 1924. Part 11: Pacific Slope Basins in California. Pp. viii+448 50 cents (Washington, D C.: Government Printing Office.)

Smithsonian Miscellaneous Collections. Vol 81, No. 3: Morphology and Evolution of the Insect Head and its Appendages. By R E. Snodgrass. (Publication 2971.) Pp. 158. Vol. 81, No. 6: A Study of Body Radiation. By L. B. Aldrich. (Publication 2980) Pp. 54. (Washington, D.C: Smithsonian Institution.)

Actes de la Sociéte Helvétique des Sciences naturelles. 109e Session annuelle du 30 août au 2e septembre 1928 a Lausanne. Pp. 133+295+54. (Aarau: H.-R. Sauerlander et Cie.)

Conseil Permanent International pour l'Exploration de la Mer: Rapports et Procès-verbaux des Reunions. Vol. 52: Report of the Committee appointed by the Council to consider the Question of the Closure of the Moray Firth to Trawling. Pp. xviii+238. (Copenhague: Andr. Fred. Høst et fils.)

CATALOGUES.

Bulletin des publications nouvelles. 3e trimestre 1928. Pp. 32. (Paris: Gauthier-Villars et Cie)

Notes on Books. No. 254, January, Vol. 13 Pp. 99-126. (London: *Longmans, Green and Co., Ltd.*)

Watsons' Microscope Record. No. 16, January. Pp. 32. (London: W Watson and Sons, Ltd.)

Old and Modern Books: English Literature, Australasia, Canada, Ireland. (No. 24) Pp 54. (Newcastle-upon-Tyne William H. Robinson.)

Catalogue of Accessories for the Petrological Microscope and Mineralogical and Crystallographic Apparatus. (Petrac 29.) Pp. 20 (London: James Swift and Son, Ltd.)

Catalogue of Science and Technology, No. 3. Annotated and Classified List of Rare and Standard Works on Exact and Applied Science. Part 9, including 13: Engineering (Section 1) Pp. 929-1016. (London: Henry Sotheran and Co.)

Vitamin Therapy: a Concise Résumé of our Present-day Knowledge done in a form suitable for the busy Practitioner. Pp. 16. (London: The British Drug Houses, Ltd.)

A Catalogue of Books published by the Syndics of the Cambridge University Press. Pp. xv+292. (London: Cambridge University Press.)

The "Salex" Book of Lens Bargains. Pp. 48. (London: The City Sale and Exchange, Ltd.)

Taylors Bee Supplies, 1929. Pp. 44. (Welwyn, Herts.: E. H. Taylor, Ltd.)

Captain James Cook, 1728-1928. Pp. 16. (London: Francis Edwards, Ltd.)

Diary of Societies.

FRIDAY, FEBRUARY 22.

IMPERIAL COLLEGE CHEMICAL SOCIETY (in Main Chemistry Lecture Theatre, Royal College of Science), at 5.—Dr. F. A. Freeth: The Qualifications of an Industrial Chemist

ROYAL SOCIETY OF MEDICINE (Disease in Children Section), at 5.—Dr. G. Slot: A Clinical Method of Estimating Cardiac Efficiency in Children, and the Work of a Rheumatism Supervisory Centre.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—L. F. Stanley: The Construction and Calibration of a Sensitive Form of Pirani Gauge for the Measurement of High Vacua.—Prof. C. H. Lees: The Free Periods of a Composite Elastic Column or Composite Stretched Wire.—Dr. A. Ferguson and J. A. Hakes: A Capillary Tube Method for the Simultaneous Determination of Surface Tension and of Density.—Demonstration of a Standard Electrostatic Voltmeter and Wattmeter, used for Measurements of Alternating Currents at Power Frequencies at the National Physical Laboratory, by Dr. E. H. Rayner.

INSTITUTION OF ENGINEERING INSPECTION (at Royal Society of Arts), at 5 30.—A. S. Grunspan. Specification Notes and Good Practice relating to Concrete and Reinforced Concrete Work.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in Mining Institute, Newcastle-upon-Tyne), at 6.—Dr. G. W. Todd: The Relations between the Properties of Engineering Materials and their Ultimate Structures.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section) (jointly with Institutions of Civil and Mechanical Engineers), at 6.15.—W. Ford: Standardisation.

ROYAL AERONAUTICAL SOCIETY (Students' Section), at 6.30.—L. T. Brown: The Napier Lion Engine.

INSTITUTION OF LOCOMOTIVE ENGINEERS (North-Eastern Centre) (at Hotel Metropole, Leeds), at 7.—G. H. Taylor: Reduction of Weight in Rolling Stock.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section), at 7.—F. H. Terleski and others: Discussion on The Manufacture of Toilet Soap and Glycerin.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—G. Baker: Electrical Precipitation.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—G. C. Weston: Enlarging.
WEST OF SCOTLAND IRON AND STEEL INSTITUTE (at Royal Technical College, Glasgow), at 7.—Dr. W. H. Hatfield: The Response of Steels at Elevated Temperatures.
BLACKBURN TEXTILE SOCIETY (at Blackburn Technical College), at 7.30.—W. A. Walsh: Some Recent Improvements in Textile Machinery (Lecture).
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—J. Calderwood: The Application of the Heavy Oil Engine to Yachts and Small Craft.
INSTITUTION OF PRODUCTION ENGINEERS (at 83 Pall Mall), at 7.30.—The Story of a Sparking Plug.
ROYAL SOCIETY OF MEDICINE (Epidemiology Section), at 8.—Surg.-Comdr. S. F. Dudley: Human Adaptation to the Parasitic Environment.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. F. A. Bather: Lily-Stars of the Sea: How they fit their Surroundings.
INSTITUTION OF MECHANICAL ENGINEERS (Manchester Branch).
TODMORDEN TEXTILE SOCIETY.—S. Taylor: Winding and Warping (Lecture).

SATURDAY, FEBRUARY 23.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Newcastle-upon-Tyne), at 2.30.—F. E. Smyth: Diamond Boring Applied to Tapping Drowned Areas Underground.—H. C. Pawson: Land Drainage.—R. G. Lunnon: The Laws of Motion of Particles in a Fluid.—*Paper open for discussion*:—Roof Control on Longwall Faces, J. F. C. Friend.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. E. Bullock: Music in Cathedral and Collegiate Churches (III.).
HULL ASSOCIATION OF ENGINEERS (at Technical College, Hull), at 7.15.—K. G. Tidd: Marine Refrigeration.

MONDAY, FEBRUARY 25.

INSTITUTE OF ACTUARIES, at 5.—J. Bacon: An Experience of Assured Lives in the State of Mysore.—L. S. Vaidyanathan: Mortality of Indian Assured Lives.
INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—R. W. Gregory: Electric Supply to the Rural Districts of England.
ROYAL SOCIETY OF ARTS, at 8.—Sir Thomas M. Legge: Thirty Years' Experience of Industrial Maladies (Shaw Lectures) (II.).
MEDICAL SOCIETY OF LONDON, at 8.—Prof. A. H. Burgess and C. H. S. Frankau: Acute Intestinal Obstruction.
ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—W. K. Fry: Fractures of the Mandible in, and Posterior to, the Molar Region.
CAMBRIDGE PHILOSOPHICAL SOCIETY (in Botany School), at 8.45.—Dr. A. E. Barclay: Where Science and Medicine meet.

TUESDAY, FEBRUARY 26.

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.—Prof. K. Hansen: The Psychical and Allergic Factors in Asthma.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. J. G. Forbes: Past and Present Diphtheria in England and Wales, with Special Reference to the London Metropolis (I.).
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: Evolution and the Problem of Species (V.).
INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at Loughborough College), at 6.45.—J. H. R. Nixon: Motor Converters.
INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—R. A. Chattock: The Modern Use of Pulverised Fuel in Power Stations.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—A. K. Tallent: A Simplified Method of Screen Negative Making.—R. E. Owen: Physical Development and the Nature of the Latent Image.
INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—Prof. C. H. Desch: The Deformation of Metals.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.
ROYAL AERONAUTICAL SOCIETY (Leeds Branch).—N. S. Norway: Control of Rigid Airships.
MANCHESTER ATHENÆUM TEXTILE SOCIETY.—H. Broadbent: The Law of Contracts (Lecture).

WEDNESDAY, FEBRUARY 27.

LIVERPOOL ENGINEERING SOCIETY (at The Temple, Liverpool), at 6.30.—Mr. Woolnough: Valves for Reciprocating Steam Engines.
INSTITUTION OF AUTOMOBILE ENGINEERS (Manchester Centre) (at Engineers' Club, Manchester), at 7.—H. Kerr Thomas: Some Investigations into the Performance of Tubular Radiators for Motor Vehicles.
INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (jointly with Midland Centres of Institutions of Civil and Mechanical Engineers) (at Midland Institute, Birmingham), at 7.—Capt. J. M. Donaldson (Power Systems), J. G. Hines (Telephone Systems), and others: Discussion on The Anticipation of Demand, and the Economic Selection, Provision, and Layout of Plant.
INSTITUTION OF WELDING ENGINEERS (at Birmingham Chamber of Commerce), at 7.—C. S. Milne: Welding and Cutting Practice with Low Pressure Plant.
SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at 39 Elmbank Crescent, Glasgow), at 7.15.—Dr. F. S. Sinnatt: A Fuel Research Subject.
HALIFAX TEXTILE SOCIETY (at White Swan Hotel, Halifax), at 7.30.—Dr. S. G. Barker: Alkaline Standards for Scouring and Effect upon Dyed Goods, etc. (Lecture).
ROYAL SOCIETY OF ARTS, at 8.—A. F. Suter: Resins.
EUGENICS SOCIETY (at Royal Society).
SOCIETY OF CHEMICAL INDUSTRY (Newcastle-on-Tyne Section) (at Armstrong College).—S. A. Wikner: Tar Distillation (IV.).

THURSDAY, FEBRUARY 28.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South Midland District) (at Town Hall, Southall), at 10.45 A.M.
ROYAL SOCIETY, at 4.30.—Sir Charles Martin and others: Discussion on Ultra-Microscopic Viruses infecting Animals and Plants.
LINNEAN SOCIETY, at 5.—Symposium on the Occurrence of Natural Hybrids:—Dr. A. W. Hill: Hybridisation in the New Zealand Flora, with Special Reference to *Gaultheria*.—E. M. Marsden-Jones and Dr. W. B. Turrill: Hybridisation in Certain Genera of the British Flora.—Prof. C. E. Moss: Some Natural Hybrids of *Clematis*, *Anemone*, and *Gerbera* from the Transvaal.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. J. G. Forbes: Past and Present Diphtheria in England and Wales, with Special Reference to the London Metropolis (II.).
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. A. O. Rankine: Physics in Relation to Oil Finding (II.).
BIOCHEMICAL SOCIETY, BIRMINGHAM UNIVERSITY, at 5.30.—A. G. Norman: Immunity.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Ll. B. Atkinson: How Electricity Does Things (Faraday Lecture).
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—R. A. Fraser: The Flutter of Aeroplane Wings.
INSTITUTE OF METALS (Birmingham Local Section) (jointly with Birmingham Metallurgical Society and Staffs Iron and Steel Institute) (at Engineers' Club, Birmingham), at 7.—W. A. Benton: Metallurgy and the Evolution of the Balance.
INSTITUTION OF THE RUBBER INDUSTRY (Manchester and District Section) (at St. Mary's Parsonage, Manchester), at 7.—H. Page: The Distribution of Compounding Ingredients in Rubber Mixings.—W. H. Reece: Chemical Reactions in Rubber Compounds (I.): Litharge and Pine Tar.
INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Royal Hotel, Luton), at 7.30.—G. Baston: Some Notes on Gear-box Design.
INSTITUTE OF BREWING (Yorkshire and North-Eastern Section) (at Queen's Hotel, Leeds).—R. Seligman: Applications of the Plate Heat Exchanger to Brewery Purposes.

FRIDAY, MARCH 1.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7. Informal Meeting.
SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at Engineers' Club, Manchester), at 7.—Prof. T. P. Hilditch: Recent Advances in our Knowledge of the Structure of the More Common Fats.
INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section), at 7.—W. Lawson: The Rotor Bearings of Electricity Meters.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Informal Meeting) (at Newcastle-upon-Tyne), at 7.15.—Sir Joseph Isherwood, Bart., and others: Do the Rules of Classification Societies tend to improve Shipbuilding and Engineering in this Country?
GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—S. E. Hollingworth: Evolution of the Eden Drainage in the South and West.—M. Chatterjee: The Accessory Minerals in the Bodmin Moor Granite.
JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—L. S. Atkinson: The Control of Electric Lifts.
INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at 51 West Regent Street, Glasgow), at 8.—E. C. Philbrow: Inspection.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Robert Robertson: Infra-Red Spectra.
ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (Birmingham Conference on Chromium Plating).

SATURDAY, MARCH 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Molecular Motions in Rarefied Gases (I.).

PUBLIC LECTURES.

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LONDON SCHOOL OF ECONOMICS, at 5.—C. E. R. Sherrington: Air Transport and the Disintegration of Economic Barriers.
UNIVERSITY COLLEGE, at 5.30.—Dr. J. H. Jones: Hygiene of the Mercantile Marine. (Succeeding Lectures on Mar. 1 and 8.)

SATURDAY, FEBRUARY 23.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. Bernard Smith: Zermatt and its Glaciers.

MONDAY, FEBRUARY 25.

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EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—T. Hacking: The Law in Regard to the Sale of Milk.

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THURSDAY, FEBRUARY 28.

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UNIVERSITY COLLEGE, at 6.—W. G. Tarrant: Estate Development and its Relation to Town Planning.

SATURDAY, MARCH 2.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Prof. J. R. Ainsworth Davis: English Food, Past and Present.

NATURE

SATURDAY, MARCH 2, 1929.

CONTENTS.

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The Place of Biology in School Science.

ATTENTION has recently been directed by Mr. Ormsby-Gore and others to the lack of adequately trained men to supply the urgent needs of the Empire for biologists. The need has existed for a long while, but the position has never been dealt with in a comprehensive way, possibly because there was no practicable method of awakening that general interest in the problem which is an essential prelude to its solution. It may now be confidently said that interest is at last aroused, and the time is ripe for attacking the problem itself. There has been a highly significant change in the attitude of the average citizen to the multitudinous problems of Empire, and he now realises how intimately he is concerned in the ordered development of overseas resources. By its general activities, and perhaps above all by its publicity campaign, the Empire Marketing Board is driving home this new outlook, while for some time past it has formed the guiding principle in official circles: we need only instance the new organisation of the Dominions and Colonial Offices, the reports of Commissions that have examined some of the problems in the non-self-governing Colonies, the Research Grants Committee of the Empire Marketing Board, the first Imperial Agricultural Research Conference, and the personal visits of Mr. Amery and Mr. Ormsby-Gore to the Dominions and Colonies. The most important common factor brought out in all these activities is the opportunity for the trained biologist. Innumerable problems await him in every form of agriculture, in forestry, and in education.

There is little doubt that the grave shortage of qualified men would not have occurred had biology not been neglected in the school science course. It is perfectly true that the small proportion of men destined by natural gifts to become leaders in some branch of science are little affected by gaps in their early training; but the spade work, on which the general orderly advance of a subject and its actual employment in practical problems closely depend, is done by men of less transcendent qualities, who form the bulk of the class of professional scientific workers. These men are undoubtedly moulded to some degree by their early education, in the sense that although they are evidently potential scientific workers, the particular branch that they will follow usually depends on what was put before them in their impressionable years. It is well to stress the vital control that the educational syllabus has in maintaining the supply of competent research workers in any branch of

science. German physics and chemistry and their industrial applications provided the outstanding illustration of the pre-War period. This achievement was once described by, we believe, Sir William Ramsay as "the triumph of the second-rate." The phrase can be construed as cynical in intention, but its true meaning is surely that the success depended on adequate training for the mass of research workers, who were only second-rate in comparison with the few men of genius.

The science curriculum of British public and other secondary schools is almost exclusively occupied by formal physics and chemistry, and it is not surprising that recruits for other branches of science are relatively few. Yet it is not easy to make any change, although the desirability of doing so seems evident. The matter has been under careful examination by committees of the British Association, dealing respectively with "Science in the School Certificate Examination" and "Animal Biology in the School Curriculum." The former is naturally the more comprehensive, and makes a clear distinction between science teaching as part of a general education, and as preparation for professional qualification or a degree. It is generally forgotten—and the recent correspondence in the *Times* is no exception—that only a very small proportion of secondary school pupils proceed to universities. Probably 96-97 per cent finish their formal education at the age of sixteen, and the remainder have already begun to specialise in the subjects they intend to follow at the university or elsewhere.

Both classes suffer through the almost complete neglect of biology in their curriculum. The former class have not a properly balanced outlook on science and its manifold relations to the modern world, while in the latter class there are, as already mentioned, potential biologists who will nevertheless become physicists and chemists. The scope and intention of the biological teaching—or better, of the balanced scientific teaching—must be different in the two cases, but obviously the primary need is that the science course in both the preparatory or elementary school and the secondary or public school shall contain an adequate amount of biology. There would be little difficulty about this if our existing educational structure could be demolished and built afresh, for any attempt to graft additional subjects on to an already overcrowded curriculum is faced by grave difficulties. On one hand there are the enthusiasts who would jettison something to make room; some suggest that non-scientific subjects should be reduced: others that physics, chemistry, and mathematics should be curtailed. On the other hand, there are the (unkindly described) vested interests, who assert that the time available for science is already cut to the bone. Meanwhile the vicious circle remains: even if biological subjects were introduced to-morrow, few qualified teachers could be found.

It almost appears that the advocates of biological teaching have unwittingly delayed, by over-emphasis, the reforms they have at heart, for they have created more than a suggestion that the present science teaching is out of touch with realities. It is asserted that physics and chemistry courses have become more and more formal; that, for example, a lad may, and does, acquire a dexterity in dealing with weightless strings passing over frictionless pulleys, while entirely failing to appreciate the part that mechanics plays in his daily environment and in the functioning of his own body. There is some truth in the statement, but the question whether it is a valid criticism needs a little closer examination. If there is one thing essential in the present-day civilisation, it is that those who live in it should be able to think accurately. The more complex the environment the more must our actions be based on quantitative rather than qualitative reasoning. The logical application of this axiom leads to a science syllabus in which physics and chemistry predominate, for these subjects, together with their servant, mathematics, are quantitative in their very essence; biology is not, and possibly may never be so, although a beginning has been made by applying the exact sciences, and biochemistry and biophysics already have great achievements to their credit. Since physics and chemistry were first in the field, and in view of their quantitative nature, it is not surprising that they have been used almost exclusively in teaching the virtue of accurate reasoning.

Another claim, recently expressed, is that education and biology can be defined in almost identical terms: education is concerned with the living individual and the habitat in which he must live and work out his destiny; biology deals with the nature of living things and the relations to their environment. Expressed in this way, the definitions seem at first sight interchangeable, but in reality the latter one is the narrower. In the sense in which they are used above, the word 'habitat' has a much wider significance than 'environment.' The human habitat includes the whole range of uses that man has made of inanimate Nature, and it is precisely these achievements that are of most interest to the educated man to-day. The reason

is not far to seek. They give him a faint glimpse of the illimitable and amazing powers that his descendants may wield, and, on a more mundane plane, they contribute greatly to his material security, his comfort, and his recreation.

There is a tendency for the exponents of biological teaching to assume that these immediate material benefits conferred on our civilisation by the applications of physics and chemistry have been responsible for the concentration on these subjects in the schools. Proceeding from this assumption, the argument states that they continue to be taught partly from inertia, but also because they are a useful accomplishment in seeking a living, and by way of emphasis it concludes with the statement that if men were still bought and sold as in slavery times, human biology would possess equal importance. But both the assumption and the argument are unsound; as to the assumption, the most commercially minded physicist has not lost his sense of wonder that a few pieces of wire, put together in a certain manner, should enable him to hear the voice of a fellow-man thousands of miles away; and as to the argument, cattle have been bought and sold for a long time, but it cannot be said that the breeders make much use of modern animal biology. Wherever we look we find the same dominance of the physical world. As an example we may take the yearly attendance figures for the Natural History and Science Museums, and now that each is in a permanent building the comparison is a fair one. The number of visitors to the Natural History Museum has exceeded the half-million mark each year since 1924, and shows perhaps a slight tendency to increase. The attendances at the Science Museum have risen from 430,000 in 1925 to 709,000 in 1927, while the 1928 figure just exceeds 900,000.

To take a lighter illustration, the twenty-fifth anniversary of the first flight of the brothers Wright was celebrated by a dinner under the wings of the historic biplane, attended by pioneers in the art and science of aeronautics, but no similar tribute was offered to the pterodactyl even at the centenary of Cuvier's elucidation of its true nature.

We have to face the fact that the average citizen is not intensely interested in the biological nature of his own existence, and yet it is highly desirable that he should be. Hence the introduction of biology into primary and secondary education must be achieved in the face of a certain apathy, coupled with protests both from the commercially minded and those educationists who fear a loosening of discipline in science teaching.

Apathy will disappear in proportion as interest is aroused. When the opportunities for biologists in the overseas Empire and at home are fully appreciated by schools and by parents, any objections on the ground of unsuitability as a preparation for a professional career will disappear. In this connexion we hope that the authorities will arrange for the widest possible distribution of two leaflets prepared by direction of the Imperial Agricultural Research Conference. These deal with the opportunities for students of biology; one is addressed to teaching authorities, the other to parents and students, and both set out in moderate terms the bright prospects for some time to come for able young biologists. The final hurdle, however, is the most formidable; it is to persuade a well-entrenched system of science teaching, conscious of its intellectual and utilitarian value, and proud above all of its value as a mental discipline, that it is nevertheless incomplete without biology. How is this to be done? Bateson himself supplied the answer in his article in the Huxley Centenary issue of Nature: "No one better than Huxley knew that some day the problems of life must be investigated by the methods of physical science if biological speculation is not to degenerate into a barren debate."

There would be few to dispute that primary science education should concentrate on the simplest—we might almost say the picturesque—aspects of Nature, and here the various phases of biological science naturally predominate. But for the next stage, the secondary or public school period, the pupil must be brought into closer touch with realities, and the discipline of exact and critical thinking must be firmly established. For this purpose it appears inevitable that wherever possible the approach to biology must be through the medium of physics and chemistry, although the subject must naturally be presented in proper perspective, and in some of its more complex branches only qualitative methods of exposition will be possible for some time to come.

The consent of educationists to this outlook would be tantamount to accepting a course in general science as the backbone of pre-university teaching. The foundation of the course would still be physics and chemistry, but it would also include studies of living things and of the changeful earth generally. Its value as a mental discipline need not be reduced, and its human interest would be greatly increased. The net would be thrown wider, and it would assuredly produce a greater number of recruits for biology than the present system.

Pure Substances: their Preparation, Properties, and Uses.

La notion d'espèce en chimie. Par Prof. Jean Timmermans. Pp. iii + 134. (Paris: Gauthier-Villars et Cie, 1928.)

PROF. TIMMERMANS has chosen as a basis for his monograph on "Chemical Species" the definitions given by Wald in 1897, and used by Ostwald in 1904 in the Faraday Lecture in which he tried to show that the molecular theory had become a superfluous hypothesis in view of the rapid development of the applications of thermodynamics to chemistry. According to these definitions, a *chemical compound* is merely a 'hylotropic' substance which remains constant in composition over a range of temperatures and pressures, within which it resists all attempts at fractionation. A *solution*, on the other hand, may remain of constant composition when attempts are made to fractionate it by a single method, for example, by distillation under a given pressure, but generally begins to break up when a second process of fractionation is tried, for example, by fractional distillation under a different pressure, or by freezing. If, however, the material remains hylotropic and resists fractionation under all available conditions, it is classed as an *element*.

These definitions appear to be strictly logical, but do not provide an immediate solution of the practical problem of recognising a chemical compound. Thus it is not easy to say under what physical conditions stable oxides such as magnesia or alumina begin to dissociate into their components, although a schoolboy could prove their complexity by a synthetic method. In cases such as these, the attempt to find a physical definition of a chemical species seems to lead to less satisfactory results than the traditional chemical methods.

A converse difficulty arises in the case of substances which undergo isomeric or polymeric change. Their behaviour then depends entirely upon the velocity with which this change takes place. If the change is slow, the two substances will behave as distinct species, and can be fractionated in the ordinary way, provided that the process of fractionation is fast in comparison with the velocity of change. Since, however, this velocity is often increased enormously by the presence of catalysts, it may be necessary to take exceptional precautions to maintain the purity of the sample, for example, by using silica containers in order to avoid contamination by the alkali of a soft glass vessel. If these precautions are not taken, or if the velocity of change is inherently fast, the two species will behave as one; and no process of fractionation will be of the slightest use unless it can outrun the isomeric or polymeric change. Substances of this kind will be hylotropic under all conditions, except those which give rise to a fundamental decomposition. The hylotropic phases, if liquid or gaseous, will be equilibrium mixtures of the different species; but if a solid phase crystallises out, it will generally consist of a single species, since separation of the first crystal from the liquid or gaseous phase is immediately followed by a restoration of equilibrium, which results ultimately in a complete conversion into the solid species of lowest vapour pressure.

It is necessary to lay stress on the complete breakdown of the usual criteria in cases of this type and to assert as clearly as possible that merely negative evidence has no value as a proof of molecular uniformity. Thus the author cites Sidgwick's test for distinguishing between isomers and polymorphs, by observing whether an increased concentration is produced by saturating a solvent with both solid phases. If an increase is observed, the difference between the two solids is evidently maintained in the liquid phase and by definition the two forms cannot then be mere polymorphs; but Prof. Timmermans falls into a common error by quoting a case in which no increase of solubility is observed, and concluding from this evidence that "the two substances are polymorphic forms of the same compound." On the other hand, if one form is colourless and the other coloured, or if the two forms show a marked difference of colour, it can generally be asserted with some confidence that they are probably different species, even if their saturated solutions are identical in concentration, refractive index, optical rotatory power, etc., since it is unlikely that any mere rearrangement of the crystal lattice will suffice to produce a coloured aggregate from molecules which are colourless when packed in a different way. The only logical conclusion in such a case is to treat the coloured and colourless molecules as different species, but to assign a high value to the velocity of transformation.

It is indeed impossible to be quite certain that any given case of polymorphism may not be accompanied by molecular transformation, although this is less likely to occur in the case of an element, such as iron, where the molecules appear to be composed of single atoms which cannot be accused of any tendency to undergo changes of this kind. The fact that the interconversion of white and

grey tin is complete, whilst that of the two dichloroethylenes is reversible, does not depend, however, on the fact that the two forms of the element are polymorphic, whilst those of the organic compound are isomeric (as is suggested in the text), but on the fact that the former are solid, whilst the latter are liquid.

The practical work of determining the physical properties of pure substances is a task to which Prof. Timmermans has devoted himself for some years, and on this subject he can now speak with unrivalled authority. In this respect he is the principal upholder of the British tradition of exact physico-chemical measurement, which he inherited as a student of Prof. Sydney Young, and can also claim the privilege of having worked under Prof. Kamerlingh Onnes at Leyden and under Prof. Ph. Guye at Geneva.

The difficulties of this work are twofold, since its value depends equally on chemical purity and accurate physical measurements, and there are not too many data which are above reproach in both respects. Thus, on one hand, it is necessary to write down as mere approximations the ordinary data as to the properties of organic compounds, such as melting-points determined with uncalibrated thermometers, often without any correction for the exposed stem; but it is equally clear that precise physical determinations of the physical properties of creosote (the only example of magnetic rotatory dispersion cited by Drude), or of hydrocarbons separated from petroleum by fractional distillation, have no greater claim to accuracy. Whilst, therefore, the first part of Prof. Timmermans' monograph deals, as it should, with the theoretical difficulties which are met with in trying to define a chemical species, the second and third parts deal with the practical problems encountered in preparing pure substances and determining their physical properties.

It is not necessary to repeat here the valuable advice, and the equally necessary warnings, which are now given, since those who are interested in similar work would be well advised to read the words of the author rather than a paraphrase by the reviewer. A more useful purpose may therefore be served by directing attention to the valuable service rendered by the Bureau International des Étalons Physico-chimiques, of which Prof. Timmermans has been the director since 1922. This bureau, although financed largely by Belgian industrial chemists (and notably by the firm of Solvay et Cie.), also forms a permanent part of the activities of the Union Internationale de la Chimie, ranking alongside the commissions which are responsible for preparing the Tables of Atomic Weights and the Annual Tables of Numerical Results. It is indeed one of the functions of the Bureau to fill up the gaps in the existing tables of physical constants; but this is being done in a systematic rather than in a piecemeal manner by preparing various series of pure organic compounds, such as the hydrocarbons and their halogen derivatives, the alcohols, ethers, oxides, ketones, and aldehydes of the fatty series, and then determining for each compound the boiling-point (to $\pm 0{\cdot}05°$) and its variation with pressure in the neighbourhood of 760 mm., the freezing-point, the critical solution temperature, the density at 0°, 15°, and 30° C., and the coefficient of expansion, the indices of refraction at 15° for eight different rays, with their temperature coefficients, dispersion, and molecular refraction. The data thus obtained are compared critically with all the earlier measurements that are available, and are submitted to correspondents (of whom the reviewer is one) in each of the countries represented in the Union Internationale before being printed, with the result that in the course of the next five years there should become available an unrivalled series of standard measurements on a wide range of pure substances.

These data can then be used, on one hand, as a means of testing the purity of samples prepared and used all over the world, since a sample of benzene, or cyclohexane, or ethylene bromide which melts at a lower temperature than that finally adopted as correct cannot be regarded as adequately purified. On the other hand, the physical constants of the pure compounds can be used in the calibration of instruments of measurement in any laboratory, however remote. This applies not only to thermometry, where the fixed points are almost always determined in this way, but also to calorimetry, where the water capacity of the instrument can be checked by the combustion of pure benzoic acid, and to measurements of viscosity, surface tension and the like, where absolute calibration is difficult or impossible in an apparatus of normal type.

In view of the latter method of using pure substances, the Bureau des Étalons has undertaken to supply standard materials for calorimetry, refractometry, viscosimetry, and thermometry (both at high temperatures and down to $-160°$ C.), and proposes to add to this list suitable substances for the calibration of measuring vessels at low temperatures, of manometers and potentiometers, and, in addition, to extend the scope of its work

by including inorganic as well as organic substances. These materials can be procured from the Director, Bureau des Étalons, Université de Bruxelles (Solbosch), Belgique, and, by a reciprocal arrangement, materials purified by the Bureau of Standards in Washington can be purchased from the same address, whilst the Belgian products are also available in Washington. T. M. LOWRY.

Illumination in Mines.

Mine Lighting. By Dr. J. W. Whitaker. (Monographs on Coal-Mining.) Pp. xvi + 200. (London: Methuen and Co., Ltd., 1928.) 8*s*. 6*d*. net.

DR. WHITAKER'S little book has been published at a very opportune moment, for the attention of all connected with coal mining is becoming increasingly focused upon the question of underground illumination. The fact was clearly brought out at the recent annual meeting of the Institution of Mining Engineers, where one of the most important of the papers presented, and one which gave rise to a particularly keen discussion, was devoted to this subject.

Quite apart from the undoubted fact that in the mine, as everywhere else, no man can possibly do efficient work unless he is supplied with an adequate amount of light to enable him to see clearly the work upon which he is engaged, in coal mining there is the additional consideration that, in the opinion of Dr. J. S. Haldane, Dr. L. T. Llewellyn, and other authorities, that very distressing and troublesome disease, miner's nystagmus, is due essentially to deficient lighting. It is quite true that other medical men have contested this opinion and have brought forward other possible causes, but so far the weight of opinion, strongly supported by the findings of the Nystagmus Committee, inclines to the view that the cause is as above stated, and the author of the book now before us seems to share this view.

It is well known that in the vast majority of collieries in Great Britain it is necessary to employ only safety lamps. It is also well known that when safety lamps were first devised, it was the importance of safety that was mainly stressed in the first instance, and it was only later, when the conditions of safe light were thoroughly understood, that the amount of illumination received attention. How greatly this question has been overlooked until quite recently may be gathered from the Government memorandum on "The Test of Safety Lamps," published in 1912, in which the only photometric test exacted from flame safety lamps is that the lamp is required to give a minimum candle-power of 0·30 during a period of ten hours. It is now generally admitted that the miner requires at least ten times as much light as is imposed by the above Government legislation.

There is still a great deal of ignorance on the subject of mine lighting, even amongst the most progressive colliery managers, and Dr. Whitaker's little book should go far to dispel this ignorance, because it places in the hands of the colliery manager a small, clearly written, and very complete work on the subject. The author commences by explaining the properties of light, and then proceeds to the units of photometry and a description of various photometers; it is to be regretted that amongst these he has not included the very simple but quite efficient photometer recently devised by Drs. Haldane and Wheeler. A chapter is devoted to a description of the eye and a discussion of vision, whilst the nature of miner's nystagmus is also discussed. Considerable attention is devoted to the history and development of the flame safety lamp; then come chapters describing various types of electric lamps, whilst another chapter is devoted to acetylene mine lamps, and another useful chapter deals with the arrangement and operation of colliery lamp rooms.

In the chapter on acetylene mine lamps no mention is made of the fact that acetylene safety lamps have been made and put on the market, although it is quite true that they have not met with any general acceptance. Under the heading electric lamps, cap lamps are certainly discussed, but it may well be said that they have received less attention than their importance appears to warrant.

Perhaps the most serious omission in the book is that the flame lamp is considered only as an illuminating appliance and its other very important function, namely, that of a detector of fire-damp, is not considered. No doubt the author could be justified in claiming that this consideration lies outside the scheme of his work, but in fact it is very difficult to divorce the two uses of the flame safety lamp from each other. There is little doubt that if the electric safety lamp were as capable of being used for gas detection as is the flame safety lamp, it would long ago have displaced the latter, and the flame safety lamp only holds its own on account of its value as a gas detector. Great efforts have recently been made to improve the illuminating power of the flame safety lamp, so as to enable it to compete on this score with the electric lamp, but it is still too early to say whether

these efforts will or will not be attended with success. If such an improved safety lamp can be produced without at the same time impairing its value as a gas detector, there is little doubt that it would be preferred to the electric lamp, and everyone interested in coal mining sincerely hopes that such an improvement may be the outcome of the experiments that are now being carried out.

If such advances are actually made, Dr. Whitaker will no doubt take care to chronicle and describe them in a future edition. Meanwhile it can only be said that this work offers a safe guide to all interested in this important subject, and is worthy of careful study by all engaged in colliery work.

Archæological Discovery in China.

Archives de l'Institut de Paléontologie humaine. Mémoire 4: *Le paléolithique de la Chine.* Par M. Boule, H. Breuil, E. Licent et P. Teilhard. Pp. viii + 138 + 30 planches. (Paris: Masson et Cie, 1928.) 160 francs.

THE archæological discoveries in China of Fathers Teilhard de Chardin and Licent, of which a preliminary account appeared in *L'Anthropologie*, T. 35, p. 201, 1925, are the subject of a magnificently illustrated memoir written in collaboration with MM. Marcelin Boule and H. Breuil, which is now published by the Institut de Paléontologie humaine. The reverend fathers are responsible for the narrative account of the investigations at the palæolithic sites of Choei-tong-keou and Sjara-osso-gol, and the description of the worked quartzite implements from the base of the loess, while M. Boule deals with the palæontology in collaboration with P. Teilhard and also contributes an introduction, and H. Breuil examines the implements from each site in detail. The investigations which have produced the important results here described were undertaken at the instance of the Institut, which sent P. Teilhard to China in search of evidence bearing upon the antiquity of man in Asia. The prescience which directed and sent out the mission has been fully justified. The results, now that they have been placed in their proper perspective by careful scrutiny in the laboratory of the Institut, are of first-rate importance.

On geological and palæontological grounds, the pleistocene of China is equated with that of Europe. It would appear that the range backward in time of the loess has been much over-estimated and that preceding conditions in China and Europe may be regarded as very much the same. The fauna are strictly comparable both in time and character, the differences, notably in the predominance of the gazelle type, being due to climatic and geographical conditions. There would thus appear to be adequate ground for the inference that in pleistocene times there was a continuity of conditions in Europe and Asia extending from China to Central Europe and even to France.

For prehistory this is a conclusion of first-rate importance, not merely in the equation of palæolithic man in Europe and in China, but also in certain consequential inferences. The Chinese industries were advanced Mousterian—Early Aurignacian. Not only are early Palæolithic types entirely absent, but notwithstanding the Mousterian types, the characterisation of the industry as a whole is Upper Palæolithic. Again, the two sites are not identical, the most noticeable difference being the higher number of microlithic implements at Sjara-osso-gol, where they were about a third of the implements found. In the absence of comparable stratigraphic evidence it is impossible to say if this indicates a later phase. Probably it does not, but is due entirely to local conditions. The Abbé Breuil thinks it may represent an ethnic or tribal distinction. However that may be, in the main feature the two sites agree—the conjuction of various Palæolithic types which in western Europe would belong to different periods. M. Boule compares the Siberian sites, and, having these in view, it is suggested that Asiatic conditions must not be judged by a test which may apply only to the special circumstances of western Europe. M. Boule puts forward the view, and in this he is followed by his collaborators, that Asia was a vast workshop in which the stone industry was elaborated. It was in advance of Europe at corresponding epochs of time, while the precise differentiation of the various industries in Europe demonstrated by the stratification was due to successive migrations from the common source.

It cannot be denied that this theory is attractive and that there is much to be said for it. Nor must too much store be laid upon the absence of early types of implement when so much remains unexplored. Yet if the East Anglian evidence be accepted, it does seem singular that the earliest handiwork of man or his predecessor should appear in western Europe. Now that parity of conditions has been established in China, we may perhaps expect to hear of evidence which previously has been overlooked through failure to appreciate the circumstances.

Our Bookshelf.

Introduction à la théorie des quanta : les équations de la mécanique et de l'électronique. Par Dr. Marcel Boll et Charles Salomon. (Collection de Physique et Chimie.) Pp. xx + 457. (Paris : Gaston Doin et Cie., 1928.) 85 francs.

ANYONE who opens this admirable book expecting to find in it a discussion of the quantum theory will be completely disappointed. After some fifteen introductory pages the quantum theory is practically never mentioned. But such a reader's disappointment will be his own fault. There is still no proper introduction to the quantum theory other than a thoroughgoing study of classical mechanics and electrodynamics. This book contains a really excellent account of these subjects, aimed, as the authors say, at subsequent study of the quantum theory.

The subjects are studied, as they should be, on their own merits, but the emphasis and choice of material has been influenced by the needs of the student of the quantum theory. We have met no better introductory work on general dynamics and electrodynamics to put into the hands of a student who desires to approach the quantum theory with a substantial knowledge, not a mere smattering, of these important subjects. During a first reading the treatment of almost every section seemed good and complete, with the exception of that on the difficult theory of the adiabatic invariance of the action variables of a multiply periodic system. The difficulty introduced by accidental degeneracies during the change of parameter seemed not to be fully faced, though there is a summary of the important work of von Laue.

The book can be heartily recommended as *the* book for physicists on general dynamics.

R. H. F.

Elementary Organic Chemistry. By Homer Adkins and S. M. McElvain. (International Chemical Series). Pp. xi + 183. (New York : McGraw-Hill Book Co., Inc. ; London : McGraw-Hill Publishing Co., Ltd., 1928.) 11*s.* 3*d.* net.

THIS book was written to supplement a short course in organic chemistry given at the University of Wisconsin, and in consequence does not appear to be complete in itself or to agree with the inclusion of 'Elementary' in its title. The beginner would be bewildered by the number of compounds dealt with in rapid succession in the first chapter of some 32 pages, and in the subsequent chapters the usual procedure is to consider a homologous series in a very general manner with only the briefest reference to the most important members of the series, or in some cases to omit them completely. Thus in the chapter on aldehydes and ketones, acetone is not even mentioned.

The authors have laid great stress on structural formulæ, which are printed in large type (in fact, the reaction showing the formation of fluorescein occupies nearly a page), and spend considerable time on nomenclature, which is so often neglected in elementary text-books ; but unfortunately these are almost the only points in favour of the book, as it could not be used by a beginner unless to supplement some course of lectures, and then only if these followed the general arrangement of the book.

J. R. H. W.

Bells Thro' the Ages : the Founders' Craft and Ringers' Art. By J. R. Nichols. Pp. xi + 320 + 53 plates. (London : Chapman and Hall, Ltd., 1928.) 21*s.* net.

To meet the revived interest in bells, and because most of the books on the subject are out-of-print or inaccessible, Mr. Nichols, himself a member of the Ancient Society of College Youths and the Lincoln Diocesan Guild, has written this study of bells and bell-ringing. In his view, the period in the seventeenth and eighteenth centuries which has been called the 'Golden Age of Bell-founding' is in danger of losing its claim to that title owing to the activities of modern founders. Be that as it may, his volume will be welcome to the practitioners of the art and those whose interest in the subject calls for a convenient book of reference.

Mr. Nichols' treatment of the subject on the historical side is comprehensive. Not only are famous bells described in detail, but also he deals with the history of the methods of ringing, the peal, the chime, the changes, and so forth, famous founders, inscriptions and decorations on bells, and of course with the carillon. A chapter is devoted to lore and legends—a subject which requires a whole book to itself, and certainly a broader treatment than Mr. Nichols has given it. To dismiss the belief that bells drive away evil spirits as a mere superstition, misses the significance of the importance attached to the bell in the early Christian Church as shown especially in the lives of the Irish saints.

Sir Joseph Banks and Iceland. By Halldór Hermannsson. (Islandica : an Annual relating to Iceland and the Fiske Icelandic Collection in Cornell University Library, Vol. 18.) Pp. x + 99 + 27 plates. (Ithaca, N.Y. : Cornell University Library ; London : Oxford University Press ; Copenhagen : Andr. Fred. Höst and Sön ; Reykjavík : Bókaverzlun Sigfúsar Eymondssonar, 1928.) 15*s.* net.

SIR JOSEPH BANKS's visit to Iceland was in the summer and autumn of 1772, a time when comparatively little about that country was known in Europe. He published nothing on his journey, but it is clear a good deal of scientific work was done. Banks kept a diary, which can be traced as having been in the keeping of his wife's family until it was sold among his other papers in 1886. The present owner is unknown. Mr. Hermannsson has put this work together from various sources, and illustrated it by pictures from Iceland which were made at the time and are now in the British Museum. Banks's visit was brief, but it awakened in him a lifelong interest in Iceland. Much of the book traces through Banks's letters this interest, and his efforts on behalf of the Icelanders at a period when their fortunes were low.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

The Mass-Spectrum of Uranium Lead and the Atomic Weight of Protactinium.

It will be recalled (Nature, Aug. 13, 1927) that the identification of the isotopes of ordinary lead was made by means of a sample of its tetramethide kindly supplied to me by Mr. C. S. Piggot, of the Geophysical Laboratory, Washington. He has since succeeded in the much more troublesome task of preparing the similar compound of a rare uranium lead from Norwegian bröggerite. His reasons for this work have already been published (C. S. Piggot, "Lead Isotopes and the Problem of Geologic Time," *Jour. Wash. Acad. Sci.*, May 19, 1928). The first tube of uranium lead methide despatched to me a year ago was unfortunately broken in transit, but the second reached Cambridge safely last summer. At that time I was endeavouring to work out a photometric method of measuring the relative abundance of isotopes. This work is by no means complete, but has recently reached a stage which justified an attempt on the mass-spectrum of this very precious material. The procedure was the same as with ordinary lead methide, but the general conditions of the discharge tube, etc., were not so favourable, so that the spectra obtained are weaker.

The mass-spectrum consists of a strong line at 206, a faint one at 207, and a still fainter one at 208. The last is barely visible to the eye, but easily distinguishable on the photometer curves. The impossibility of eliminating mercury limits the search for lighter isotopes, but there is not the least indication of 203 or 205. Unfortunately, the experimental conditions all conspire to make the determination of the true relative intensities of the lines from the curve of photometer wedge readings too complex to be really trustworthy. Calling the intensity of the strong line 100, the mean of the best plates gives $10{\cdot}7 \pm 3$ and $4{\cdot}5 \pm 2$ for 207 and 208 respectively. As the only curve available for transforming wedge readings into intensities is one derived from krypton, these figures are probably both too high. They correspond to percentages $86{\cdot}8 : 9{\cdot}3 : 3{\cdot}9$, and as the packing fraction is indistinguishable from that of mercury ($0{\cdot}8 \times 10^{-4}$), the mean atomic weight deduced is 206·19, rather higher than that determined chemically for other uranium leads. These figures have been communicated to Mr. Piggot, and when combined with the analyses of the mineral should enable its age to be fixed with considerable certainty.

There is, however, another point of view from which these results are of fundamental interest in connexion with the radioactive elements. The line 207 is of peculiar significance. It cannot be due to the presence of lead as an impurity, for in ordinary lead 208 is about twice as strong as 207, neither can it be the product of radium or thorium. It is difficult to resist the natural conclusion that it is the end product of the only other known disintegration, namely, that of actinium. If this is so it settles the mass numbers of all the members of this series, that of protactinium being 231. Extrapolation of the packing fraction curve suggests an atomic weight on the oxygen scale of 231·08.

F. W. Aston.

Cavendish Laboratory,
Cambridge, Feb. 16.

Origin of Actinium and Age of the Earth.

By the kindness of Dr. Aston, I have had the opportunity of inspecting his photographs showing the isotopes of lead obtained from the radioactive mineral broggerite. As he concludes, it seems highly probable that the isotope of mass 207 is mainly due to actinium lead, and that the actinium series has its origin in an isotope of uranium—a suggestion independently put forward by several investigators on other evidence. Since six α particles are emitted in the successive changes from protactinium to the end product actinium lead, the atomic weight of protactinium should be 231. The direct determination of the atomic weight of this element number 91 now in progress in the laboratory of Prof. Hahn in Berlin should afford a crucial test of the accuracy of this deduction.

In the light of this new knowledge and of the measurements made by Dr. Aston of the relative intensities of the lead isotopes in the mineral, it may be of interest to consider its bearing on the origin of actinium and other problems. We shall first discuss the probable mass of this new isotope, which for convenience will be called actino-uranium. It seems simplest to suppose that its mass is 235, and that it undergoes first an α and then a β ray transformation into protactinium. The β ray body is probably to be identified with uranium Y, discovered by Antonoff, which has generally been regarded as the immediate parent of protactinium. On this view, the successive transformations follow the order $\alpha\beta\alpha\beta$, where the α and β changes alternate, and differ in this respect from the main uranium series which follow the order $\alpha\beta\beta\alpha$. It is of course possible to assume that actino-uranium has a mass 239 and number 92, and is converted into a mass 235 of number 92 in consequence of an α ray change followed by two β ray transformations, but no evidence has been obtained of the existence of such β ray bodies, although a careful search has been made for them by Hahn and others.

An estimate of the period of transformation of the new isotope of uranium can be deduced on certain probable assumptions. The ratio K' of the number of atoms of actinium lead to those of uranium lead can be deduced approximately from Aston's measurements, and we also know the ratio K—about 3/100—of the number of atoms delivered in a mineral into the actinium series compared with the number passing into the radium series. If λ_1, λ_2 are the constants of transformation of actino-uranium and the main uranium isotope respectively, it can easily be deduced that $K'/K = \frac{\lambda_2}{\lambda_1} \cdot \frac{e^{\lambda_1 t} - 1}{e^{\lambda_2 t} - 1}$, where t is the age of the mineral from which the lead is derived. We shall suppose for the purpose of calculation that t is 10^9 years—an average estimate of the age of old primary uranium minerals. Taking as a low estimate that $K' = 7/100$, it can be deduced from the equation that $\lambda_1/\lambda_2 = 10{\cdot}6$. Since the half-value period of transformation of uranium is $4{\cdot}5 \times 10^9$ years, it follows that the period of actino-uranium is $4{\cdot}2 \times 10^8$ years. A larger value of K' lowers the period, while a higher value for the age of the mineral raises it.

Taking the period as $4{\cdot}2 \times 10^8$ years, it is seen that the amount of actino-uranium is only about 0·28 per cent of the main uranium isotope—an amount too small to influence appreciably the atomic weight of uranium as ordinarily measured. The amount of actino-uranium at the time of its formation taken as 10^9 years age comes out to be 1·44 per cent.

There is another interesting deduction that can be made from these estimates. It is natural to suppose that the uranium in our earth has its origin in the sun,

and has been decaying since the separation of the earth from the sun. From the work of Aston, it is known that with two exceptions the most abundant isotope in an even numbered element is of even atomic weight. If it be supposed that uranium, like other heavy elements, is formed from stellar matter, it is likely that actino-uranium of odd atomic weight would be formed in smaller quantity than the main isotope of even atomic weight. Even, however, if we suppose they were formed in equal quantity, it can be shown that it would require only $3{\cdot}4 \times 10^9$ years to bring down the amount to the 0·28 per cent observed to-day.

If we suppose that the production of uranium in the earth ceased as soon as the earth separated from the sun, it follows that the earth cannot be older than $3{\cdot}4 \times 10^9$ years—about twice the age of the oldest known radioactive minerals. In addition, if the age of the sun is of the order of magnitude estimated by Jeans, namely, 7×10^{12} years, it is clear that the uranium isotopes which we observe in the earth must have been forming in the sun at a late period of its history, namely, about 4×10^9 years ago. If the uranium could only be formed under special conditions in the early history of our sun, the actino-uranium on account of its shorter average life would have practically disappeared long ago. We may thus conclude, I think with some confidence, that the processes of production of elements like uranium were certainly taking place in the sun 4×10^9 years ago and probably still continue to-day.

E. Rutherford.

The Theory of Electrical Rectification.

It is an experimental fact that certain electrical conductors, when connected in series so as to form a circuit, present a different resistance to currents flowing through them in opposite directions. Examples are the electrolytic rectifiers, the crystal rectifiers, and the dry-plate rectifiers recently developed. In some cases the rectification undoubtedly is due to the circuit itself being modified by the flow of the current. Thus, for example, in an electrolytic rectifier a layer of oxide may be formed on one of the electrodes when the current is passing in a given direction, obstructing its further flow, while no such layer appears at the other electrode, made of a different material, when the current is reversed. Thermoelectric effects may occasionally play a rôle too. In crystal rectifiers, however, the rectification must in general be caused directly by the interaction of the crystal lattices with the conduction electrons (W. Schottky, *Zeit. f. Phys.*, **14**, 63; **1923**). For it appears that they rectify alternating currents of frequency 10^7, and of the order of a microampere only (R. Ettenreich, *Phys. Zeit.*, **21**, 208; 1920), and the amount of substance chemically changed in an electrolytic action during a half period of such an alternating current is altogether too small to be made responsible for the phenomenon, quite apart from the fact that chemical changes would scarcely be capable of taking place with a frequency of 10^7. As Ettenreich (*l.c.*) remarks himself, the thermoelectric explanation too is invalidated by his experiments. The question arises then as to what is the elementary mechanism underlying this kind of rectification.

The resistance of a metallic conductor is caused by the transfer of momentum which the conduction electrons have gained under the influence of the applied electric field to the ions of the crystal lattice through collisions or, in the language of wave mechanics, by the scattering of the waves representing the conduction electrons under the action of these ions. Rectification signifies here, therefore, a difference in the scattering power of the circuit for electron waves travelling in opposite directions.

If in first approximation we regard the ions in the lattices as fixed in space, we are led to study the influence on a plane monochromatic electron wave of a field of force the potential V of which vanishes for $x = \pm\infty$, while in planes parallel to the y-z-plane it is doubly periodic. According to wave mechanics such a wave, representing a stream of electrons of definite velocity parallel to the wave normal, on encountering the potential V is partially reflected and partially transmitted. We inquire then if the coefficient of reflection for a given V is the same for incident waves travelling in opposite directions. It can easily be proved that even if the potential V is not symmetrical along the x-axis, as in the case of a number of conductors in series, there is no difference in the coefficient of reflection. It is hence not possible to explain the rectification here considered on the basis of the assumption that the ionic lattices act on the conduction electrons like a field with a given potential V.

If now we regard the ions of the lattice no longer as fixed centres of force, we come to investigate if there will be a difference in the scattering action on electron waves travelling in opposite directions, of particles bound to positions of equilibrium by restoring forces not symmetrical for equal and opposite displacements. It can be shown by a perturbation method that in general the scattering is indeed different. Assymmetrical binding of the ions, which, for some of the substances used in rectifiers actually has been ascertained even for the interior of the crystal by X-ray analysis, will come mostly into play near the boundary, and to a still greater degree at the edges and corners of a crystal lattice. This may be the explanation why some crystal rectifiers consisting of a metal point in loose contact with the crystal have their rectifying properties diminished or entirely spoiled if the point is pressed tightly against its base, for in this process the sharp corners are flattened out. From the viewpoint of the theory here set forth, there seems to exist the possibility of volume rectification in contradistinction to surface rectification for crystals in which, even in the interior of the lattice, the ions are subject to restoring forces not symmetrical for equal and opposite displacements. No experimental data appear at present available to show clearly the existence of this effect.

The proof of the reciprocity theorem for electron waves mentioned above, as well as a mathematical discussion of the difference in scattering caused by asymmetrically bound particles, will be given elsewhere.

R. de L. Kronig.

Physisch Laboratorium
der Rijks Universiteit,
Utrecht, Jan. 28.

The Extermination of Whales.

Sir Sidney Harmer, in an important paper (Linnean Society, May 24, 1928), directs attention to the wasteful way whales have been killed in the past and to the danger of exterminating them. As regards the Greenland whale, the facts seem to be worse than Sir Sidney states.

Scoresby, speaking of its capture in the Greenland Sea, says towards the end of the eighteenth century: "A striking epoch in the history of the fishing arose" . . . "two or three of the captains of the whale-fishing ships" . . . "instead of being contented with two or three large fish and (instead of) considering five or six a great cargo, set the example of doubling or trebling the latter quantity."

The increased activity thus initiated (which doubt-

less meant entering the ice to an increased extent) certainly led to the capture of a very large *number* of whales, but the statistics of the fishing prove that they yielded only a low average of oil and that many of them were of small size.

In the Greenland Sea between 1792 and 1822 Scoresby, senior, captured 533 whales and brought home (including some seal oil) 4664 *tuns* of oil, an average (without deducting anything for seal oil) of only 8·7 *tuns* (of 252 gallons, weighing about 17 cwt. 1 qr.) per whale against the 20 tons or more of the fully grown animals. Again, in the *Henrietta*, in the three seasons 1792, 1795, and 1798, he captured 79, which only boiled 457 *tuns*, or an average of only 5·6 *tuns* per whale.

The statistics of the Peterhead fleet tell the same tale; in the twelve seasons 1805–1816, the ships of this fleet captured 868 whales, which (possibly including some seal oil) yielded only 7195 *tuns*, or an average of only 8·3 *tuns* per whale.

The young whales are less wary and more easily approached than the old, and as they are often found at the edges of large unbroken fields with only confined spaces to rise and breathe in, their capture is usually easy; it was doubtless in favourable circumstances of this sort that in 1814 the *Resolution* caught 44, which averaged only about 5 tons, and that the same year the crew of the *John* captured 13 at a 'fall,' or without stopping to take a rest.

This wasteful method of carrying on the fishing soon made itself felt; up to about 1820 it remained productive enough and gave profitable employment to a large number of ships, but after that date it began to fall off, and but for the fact that the whalers had the seals to fall back on and were able to supplement their catches of whales, and for a rise in the price of whalebone, the fishing in this region would have ceased nearly a hundred years ago.

The following figures are taken from the record of the Peterhead fleet: 1800–9, average number of whales per ship per voyage, 16·8; 1810–19, 11·3; 1820–29, 7·2; 1830–39, 3·5; 1840–49, 2·1; 1850–59, 1·7.

In the Greenland Sea the Greenland whale was undoubtedly brought to a very low ebb before its pursuit was abandoned; in the 'eighties we seldom saw more than one or two at a time and seldom more than a dozen or two in a voyage. In 1890 only six were seen by all the ships, and in 1898 not a single one.

The following figures show how this branch of the trade, notwithstanding the high price to which whalebone rose, continued to decline: 1860–69 (disregarding a few killed by the Germans before they gave up the trade), 88; 1870–79, 75; 1880–89, 85; 1890–99, 38; 1900–9 (four seasons no ships in pursuit of them), 28.

At Davis Strait the sequence of events was similar to that which took place in the Greenland Sea. In this inlet the fishing commenced in 1719, and so long as it was confined to the east or Greenland 'side' the whales killed yielded a fairly high amount of oil (14 tons for the four years ending 1817) and must have been mostly of large size, but after the extension of the fishing to the 'west side' in 1820, consequent on Ross's voyage, the whales killed yielded a much smaller amount and must have been mostly of small size; for example, in the three seasons 1832, 1833, and 1834, the Peterhead ships captured 415, which on an average yielded only 7 *tuns* (equal to about 6 imperial tons) apiece, and in 1845 the *Joseph Green* killed 40, which yielded only 185 tons and a negligible amount of 'bone.'

This wasteful method of carrying on the fishing again quickly made itself felt, as the following figures taken from the records of the Peterhead fleet show: 1820–29, average number of whales per ship per annum, 9·5; 1830–39, 7·4; 1840–49, 6·6; 1850–59, 2·3.

The figures for the period 1820–50 would doubtless be higher if the ships (sailing ones) could always have got through Melville Bay and reached the west side and Ponds Bay in time; and after the introduction of 'steam' the figures again show an increase, but it was not long before they again began to decline.

In Davis Straits, as at Greenland, the whales were brought to a very low ebb, and it is very doubtful if they will ever recover the ground they have lost; the following figures speak for themselves: 1870–74, total number killed, 724; 1875–79, 343; 1880–84, 350; 1885–89, 76; 1890–94, 77; 1895–99, 58; 1900–1904, 68; 1905–1909, 31.

In the Greenland Sea the smallest whales were captured north of latitude 79°, at any rate north of 78° (in May and June) and in Davis Straits mostly at the mouths of Lancaster Sound and Ponds Bay (in June and July), and if the whalers had refrained from capturing in these situations, these branches of the whale-fishery would undoubtedly have continued productive, and an interesting and valuable animal saved from almost total extinction. Cannot the fin-whales be protected in some such way?

ROBERT W. GRAY.

8 Hartley Road,
Exmouth.

Retardation of the Ripening of Pears by the Exclusion of Oxygen.

IN view of the interest taken by growers and merchants in England and in South Africa in the possibilities of a new process for the handling of quickly ripening pears in sealed tins or in sealed and punctured tins, the following observations on the behaviour of pears in an atmosphere of nitrogen may be of scientific interest and practical importance.

As a rule, pears are gathered whilst unripe and hard. The yellowing, sweetening, softening, and

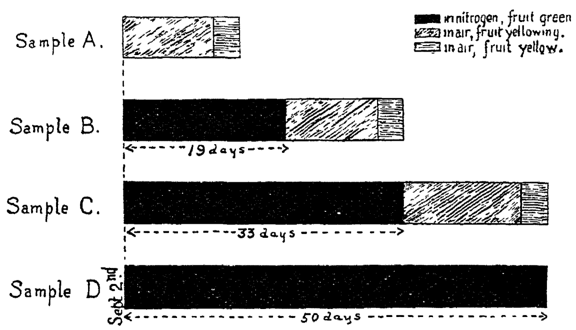

FIG. 1.—Prolonging the storage life of pears (Souvenir de Congres) by holding them in nitrogen. Although normal in appearance when removed from nitrogen after 50 days, sample *D* failed to ripen normally when removed to air.

development of juiciness and final mealiness take place in storage. In some varieties, such as the well-known Williams' Bon Chrétien or Bartlett, these changes are very rapid; in others, such as the Winter Nelis, they are slow.

If oxygen be withheld by sealing up pears in a gas-tight container over alkaline pyrogallol (an absorbent of carbon dioxide and oxygen) almost complete inhibition of the various macroscopic changes which are termed 'ripening' is brought about.

We have in this way kept in a hard green condition for several months varieties of pears which in air at ordinary room or shed temperatures softened and decayed within a week or two. The appearance of the fruit on removal after several months' storage in nitrogen was remarkable, being identical with that

shown by the fruit when placed in the sealed container. The pears, moreover, were edible and free from objectionable flavour, nevertheless they proved disappointing because they failed to yellow, ripen, and develop juiciness and the typical pear flavour.

The above is the result obtained in the extreme case of prolonged exposure to conditions of oxygen starvation. Practical and theoretical interest, however, lies in the fact that the retardation of subsequent ripening in air is a function of the time of exposure, so that by adjusting the time of exposure we can change a quickly ripening fruit into a more slowly ripening one which may attain a quality equal to that of untreated fruit.

The original observation of this phenomenon was made by us several years ago. Samples of fruit from some of the original experiments, together with the chart herewith presented, were exhibited in the Ministry of Agriculture's Demonstration Tent at the annual fruit show of the Eastern Counties Commercial Fruit Show Association held at Wisbech in the autumn of 1920.

An investigation of the effect of the variables—oxygen, carbon dioxide, and temperature—on the changes that occur in fruit during storage has since been carried out, and some of the results obtained have been described in Reports Nos. 12 and 30 of the Food Investigation Board. The rate of ripening is a function of the concentration of oxygen and of the concentration of carbon dioxide over a considerable range. Suitable concentrations of sub-normal oxygen and super-normal carbon dioxide can be obtained simply by restricting and regulating the ventilation of the stored fruit, and a crude method of doing this is to use a tin container with a small puncture in it.

Such a method is merely an extension to fruit in bulk of a mechanism with which each fruit is provided by Nature. Ventilation of the interior of individual fruits is restricted by the presence of a relatively impermeable skin with numerous small openings (the lenticels), so that the oxygen concentration in the internal atmosphere of a fruit such as the apple is always less than that in air, whereas the concentration of carbon dioxide is greater.

Franklin Kidd.
Cyril West.
Low Temperature Research Station,
Cambridge.

Regional Isostasy over the Oceans.

Important evidence that the isostatic compensation over ocean areas is regional, and not local, is furnished by the remarkable series of gravity measurements around the world made by Meinesz in a Dutch submarine, the results of which have just been published by the Geodetic Commission of Holland ("Détermination de la Pesanteur en Mer," Delft, 1928).

The provisional anomalies for 128 stations on the sea are given, reduced by several different methods. One of these, the Hayford, is based on the hypothesis of complete local isostatic compensation. These results add to the proof I have given that this hypothesis leads to appreciable error, as it is in conflict with known properties of crustal material.

Meinesz made gravity determinations over the greatest ocean depths, including the Guam and Philippines Deeps of 8740 metres ($5\frac{1}{2}$ miles). The station over each of these Deeps may be combined with a neighbouring shoal water or port station to form a pair, with greatly different ground elevations. There are seven such pairs of stations, which have depth differences of from 3600 to 8740 metres, with horizontal distances of from 23 to 83 miles only.

These ocean pairs show the same effect that I first pointed out in 1912 from similar land pairs of stations; when the Hayford anomaly for the valley station is subtracted from that for the high station the predominating difference is distinctly positive; the differences are $+0{\cdot}119$, $+0{\cdot}103$, $+0{\cdot}043$, $+0{\cdot}102$, $+0{\cdot}045$, $-0{\cdot}031$, and $+0{\cdot}064$ dyne. The positive difference is the effect of over-compensation of the high station and under-compensation of the low station, resulting from the Hayford hypothesis. The average effect for these seven pairs is $+0{\cdot}0016$ dyne for each 100 metres difference in elevation, after reducing the water depth to its equivalent in crustal material. This fact, and a rough test, show that the results for these stations will be more consistent when a regional reduction is used. This confirmation of regional isostasy by ocean observations is important, as these stations near the surface of the sea are more free from various suggested causes of local disturbance than are the corresponding land stations.

This work of Meinesz and others shows that there is still a wide field for gravimetric research as to the earth's crust. To facilitate such research the reduction methods should be put in order. They should have less confusing designations. The most used reduction is variously called 'Faye,' 'free air,' or 'elevation only,' butmore often is not named at all. 'Isostatic,' unqualified, is improperly applied to a method based on an extreme and untenable hypothesis; isostasy is a general theory, there are already a number of isostatic reductions, and there is no reason to restrict this designation to a particular brand of isostasy. Some degree of regional isostasy must be taken into account. Agreement on a convenient unit designation for 'g' is needed; 'dyne' is objected to, but 'cm./sec.^{2}' is an awkward expression for so important a unit. In investigations involving so many possible variants, as do these affecting the earth's crust, the value of differential methods should be recognised; one example is the above method of using pairs of neighbouring stations, and another would be the study of ocean and land conditions by comparison of groups of level area stations nearly in one latitude, thus eliminating uncertainties in the basic formulæ.

George R. Putnam.
U.S. Department of Commerce,
Washington, D.C.
Dec. 20,

Pre-Palæolithic Implements.

In Nature of Feb. 16, p. 257, after some comments upon my recent paper in *Proceedings of the Prehistoric Society of East Anglia* (vol. 5, pt. 3) on the further discoveries of Chellean implements derived from the base of the Cromer Forest Bed, it is stated that "it may not be out of place to direct attention in this connexion to some remarks on the subject of tertiary man in *Man* for January."

I may, however, perhaps be permitted to express my disagreement with this conclusion. To begin with, though the comments in Nature appear under the title "Pre-Palæolithic implements," the specimens described in my paper mentioned above are definitely of palæolithic age.

Secondly, as I have endeavoured to make clear on several occasions, I regard the Cromerian industries as of Early Pleistocene antiquity, and that therefore they can have no relation to any supposed problems as to the former existence of tertiary man.

Thirdly, rostro-carinate implements had been superseded by the hand-axe in Chellean times, and are, in consequence, almost unknown upon the foreshore sites under discussion, from which it follows that to attempt to involve the fundamentably different speci-

mens from these sites in the still smouldering but much enfeebled controversy as to the human origin of the rostro-carinates is futile.

A perusal, on the part of the writer in NATURE, of my papers on the flint implements from the Cromer Forest Bed should have made these various points abundantly clear. J. REID MOIR.

One House, Ipswich.

Dr. H. J. H. Fenton.

MY friends C. T. H. and W. H. M. have given in NATURE of Feb. 16 a most sympathetic account of their late colleague, Dr. Fenton. Beyond the University of Cambridge, however, there are not a few who would wish to pay tribute to his memory—especially to his greatness as a teacher. It was my good fortune to know Fenton almost intimately from an early date. We were fellow examiners in natural science at Cambridge and together gave the present master of Pembroke the degree which he has since so well shown to be a proper apprizement: it is always interesting to have early judgments verified.

Fenton was never a mere teacher of science. A man of truly scientific mind, he sought to train his pupils to be scientific, something very different. Never a believer in gods, a hater of dogmatism, he was careful to present each problem in its varied aspects, asking his hearers to balance the evidence for and against any particular conclusion—leaving them, having paid their money, to make their own choice, then with reserve. He did this with an air of aloofness, in an apparently affected, lackadaisical but actually very deliberate way, which was most arresting; time was given for what he said to soak in, a challenge to consider his argument. Fluent lecturers are rarely good teachers. I remember my son, as a medical student, being deeply impressed by his teaching—picking him out as the one lecturer worth hearing. If there were only a few teachers such as he was, the position of our science would be far higher; it would be a judicious and logical discipline.

Fenton's discovery of dihydroxymaleic acid—a true discovery—was one of the most masterly pieces of experimental work ever done, the importance of which has yet to be fully appreciated. Having in some way, in early days, fallen foul of authority, outside the Chemical Department he was never held in favour. This he bitterly resented. His queerness was not a little due to the failure of the powers that were to accord him the sympathetic recognition which he knew was owing to his services and achievements. Let us hope that someone will come forward as his biographer and display his method in all necessary detail.

HENRY E. ARMSTRONG.

An Iodine Liberator from Laminariæ.

THE evidence which Prof. Dillon brings forward in his letter (NATURE; Feb. 2, p. 161) does not entirely warrant his conclusion that the agent present in an acidulated extract of *Laminaria* fronds which liberates iodine from potassium iodine is an *organic* substance.

Inorganic oxidising agents exist, dialysable but relatively heat-labile in presence of organic matter, which might occur in his extract, and would account for his experimental findings. One of these, sodium (or potassium) *iodate*, which in pure aqueous solution in quantities containing only $0{\cdot}1\gamma$ iodine, or even less ($\gamma = 10^{-6}$ gm.), will liberate, in presence of slight excess of potassium iodide and dilute sulphuric acid, free iodine in sufficient amount to be detected by shaking the reaction mixture with a drop of chloroform, or by the addition of starch solution. In view of the large quantity of iodine in various states of combination in these algæ, and the relative ease with which iodate may be formed, the presence of small quantities of this salt is not altogether unlikely. Iodate and iodide could co-exist in the neutral or faintly acid environment of the algal tissues, but would react when the tissue or tissue-extract was rendered distinctly acid.

If results obtained using mammalian tissue-extracts are any guide to the behaviour of plant extracts, there is little doubt that a very minute addition of an iodate to the *Laminaria* extract would reveal itself as a potent 'iodine liberator,' would be dialysable, and would have the same order of heat-lability as was found for this agent by Prof. Dillon. The original extract would probably be found to be rather less active than the outer liquid after dialysis, since the former contains organic substances of high molecular weight which would be expected to combine readily with traces of free iodine, and thus inhibit to a greater or lesser degree the phenomenon of iodine liberation. It would appear that iodate, at least, should be shown to be absent before the organic nature of the iodine-liberating agent can be satisfactorily maintained.

H. D. KAY.

Medical Unit,
London Hospital,
Whitechapel, E.1, Feb. 8.

Unified Field Theory of Electricity and Gravitation.

MAY we be permitted to direct attention to a certain aspect of Einstein's three recent papers (*Berliner Berichte*, pp. 217, 224, 1928; Feb. 1929) on distant parallelism which came to light in a discussion with Prof. D. J. Struik? The avowed aim of these papers is to develop an improved unified field theory of electricity and gravitation. A much more pressing need of general relativity theory is a harmonisation with quantum theory, particularly with Dirac's theory of the spinning electron. On the basis of Levi-Cività's parallelism the task seems hopeless, inasmuch as we have no adequate means of comparing spins at different points. On the other hand, the notion of a parallelism valid for the whole of space and of Einstein's n-uples enables us to carry over the Dirac theory into general relativity almost without alteration. All that we need do is to interpret Dirac's p_0, p_1, p_2, p_3 not as differentiation with respect to four variables x, y, z, t defined throughout space-time, but as differentiation along the lines of the quadruple (Einstein's '4-Bein'). That is, the quadruples need not be integrable so as to furnish us with a co-ordinate system throughout space, for such a co-ordinate system is absolutely inessential in the proof of the invariance of Dirac's equations under a Lorentz transformation.

In other words, the quantities ${}^{s}h_{\lambda}$ of Einstein seem to have one foot in the macro-mechanical world formally described by Einstein's gravitational potentials and characterised by the index λ, and the other foot in a Minkowskian world of micro-mechanics characterised by the index s. That the micro-mechanical world of the electron is Minkowskian is shown by the theory of Dirac, in which the electron spin appears as a consequence of the fact that the world of the electron is not Euclidean, but Minkowskian. This seems to us the most important aspect of Einstein's recent work, and by far the most hopeful portent for a unification of the divergent theories of quanta and gravitational relativity.

NORBERT WIENER.
M. S. VALLARTA.

Massachusetts Institute of Technology,
Cambridge, Massachusetts, U.S.A.,
Feb. 7.

The Electronic Charge *e*.

PROF. A. S. EDDINGTON has recently (*Proc. Roy. Soc.*, A, **122**, 358; Jan. 1929) deduced a theoretical value of 136 for the well-known ratio $hc/2\pi e^2$. The reciprocal of this ratio is usually denoted 'the fine-structure constant α.' Without presuming in any way to judge the theory on which this value is derived, I should like to make a few remarks as to the numerical result. The value of the velocity of light c is known with great accuracy ($c = 2{\cdot}99796 \pm 0{\cdot}00004$). On the other hand, the value of the Planck constant h depends primarily upon the value of the electronic charge e, and the probable error in h is almost entirely due to the probable error in e. Every method for evaluating h involves e to a positive power varying from unity to two. The average power depends upon the adopted relative weighting of the different methods. These facts regarding the connexion of e and h I discussed some years ago (*Phys. Rev.*, **14**, 361; 1919).

I am at the present moment just finishing a critical investigation of the probable values of the general constants of physical science, and a detailed account of this work will be published shortly. At the present time my adopted value of h depends, in the mean, on the 1·236 power of e. Hence the *ratio* h/e^2 varies as $1/e^{0\cdot764}$. The change in this ratio demanded by Eddington's theory is approximately 1 per cent downward (0·94 per cent, using my own adopted values of e, h, and c). Accordingly, such a change requires an increase in e of approximately one and one-quarter per cent, and a resulting increase in h of about one and one-half per cent, in contrast to a one-half per cent increase in e (and *no change* in h) assumed by Eddington as required. In my opinion the commonly accepted value of e has a probable error of roughly 0·1 per cent, and it is accordingly extremely improbable that the true error is more than twelve times as great.

RAYMOND T. BIRGE.
University of California, Feb. 2.

The Boundary of the Solar Chromosphere.

THE question of the sudden ending of the chromosphere or its gradual fading away in accordance with Prof. Milne's theoretical views may not yet be settled finally by observation. Mr. R. W. Gurney is, however, under a misapprehension (NATURE, Feb. 16, p. 240) in thinking that the bright K line studied by Mr. P. A. Taylor and Mr. McCrea up to a height of nearly 100,000 km. above the sun's limb was thought to be an ordinary chromospheric line. The tangential slit happened to fall across a high prominence and the measures refer to the portions of the slit lying on the prominence, which gave a regular fading away with height; one or two obvious brightenings had to be ignored, where structure in the prominence complicated the issue. These points were easily recognised in the picture of the prominence shown in the second flash spectrum which was obtained with an objective prism.

The difficulty of the scattering of light in our atmosphere is not easy to meet, but evidence from our other plates, for example, the objective prism spectra, does not point to any serious trouble in our case. We had the good fortune to observe the sun in a perfectly clear hole in a somewhat cloudy sky. Messrs. Miller and Marriott, half a mile away, observed through thin haze. The heights of the chromospheric lines proper, which we published, were taken from the arcs given by the objective prism spectrograms of the flash, and these would not be seriously affected by light scattering. Incidentally, it may be added, they are not inconsistent with Mr. Gurney's views.

F. J. M. STRATTON.
C. R. DAVIDSON.
Feb. 18.

An Isotope of Oxygen, Mass 18.

THE weak doublets of the atmospheric absorption bands of oxygen have been found to originate from a molecule consisting of an oxygen atom of mass 18 combined with one of mass 16. The interpretation recently published by Mulliken (*Phys. Rev.*, **32**, 880; 1928) for the strong bands holds in every detail for the weak band. The isotopic rotation–zero point vibration doublets have been calculated by means of the equations of Loomis (*Bull. Nat. Res. Council*, **2**, chap. v.; 1926) and the atmospheric absorption data of Dieke and Babcock (*Proc. N.A.S.*, **13**, 670; 1927). The vibrational frequency used for the lower state is that calculated by Birge (*Bull. Nat. Res. Council*, **2**, 232; 1927) from the available data. From the above, the formulæ for the separation of the isotopic doublets in the four P and four R branches is as follows:

$$\Delta\nu_P = 2{\cdot}12 + 0{\cdot}0556[B''m^2 - \beta''m^4 - B'(m-1)^2 + \beta'(m-1)^4]$$

$$\Delta\nu_R = 2{\cdot}12 + 0{\cdot}0556[B''m^2 - \beta''m^4 - B'(m+1)^2 + \beta'(m+1)^4]$$

$$m = \frac{3}{2}, \frac{7}{2}, \frac{11}{2}, \text{ etc.}$$

The constants as given by Dieke and Babcock are

$$B'' = 1{\cdot}438 \qquad \beta'' = 6{\cdot}31 \times 10^{-6}$$
$$B' = 1{\cdot}390 \qquad \beta' = 5{\cdot}75 \times 10^{-6}$$

The average deviation of observed minus calculated separations is $-0{\cdot}05$ cm.$^{-1}$. The maximum deviation is $-0{\cdot}13$ cm.$^{-1}$. This is well within the limit of accuracy of the data. No other isotope of oxygen combined with an atom of mass 16 will satisfy the data. The data show that the normal state of the oxygen molecule has one-half unit of vibration in agreement with the wave mechanics theory.

W. F. GIAUQUE.
H. L. JOHNSTON.
Department of Chemistry,
University of California,
Berkeley, California.

Intercombinations in the Arc Spectrum of Carbon.

PROF. A. FOWLER and E. W. H. Selwyn have recently classified the lines of the arc spectrum of carbon, and identified triplet as well as singlet terms, but no intercombinations have apparently been obtained. Recently I took a heavy arc spectrum of Acheson graphite in the region λ2000, and obtained a number of lines, some new, and others recorded by previous observers like McLennan, Hutchinson, and others. I was able to identify the following intercombination lines:

	Classification.	Transition.
51313	${}^1\overline{D}_2 - {}^3\overline{P}_1$	$(2L_2 \longleftarrow L_2M_1)$
51356	${}^1\overline{D}_2 - {}^3\overline{P}_2$	(,,)
39862	${}^1\overline{S}_0 - {}^3\overline{P}_1$	(,,)

This enables us to calculate the exact differences between the fundamental levels ${}^3P_{012}$ and ${}^1D_2$, ${}^1S_0$ of $2L_2$. We get ${}^3\overline{P}_1 - {}^1\overline{S}_0 = 20474$, while according to Fowler and Selwyn it is 21142. Taking Fowler's ${}^1D_2$ value as the more correct, the values of fundamental ${}^3P$ terms have to be decreased by 667 cm.$^{-1}$. We have also lines conforming to the inner-transitions $(L_2L_2 \longleftarrow L_13L_2)$; from the new lines I have also obtained identification of some of the $(2L_1L_2M_1 \longleftarrow L_12L_2M_1)$ transition lines.

The frequency difference ${}^3P_1 - {}^1S_0 = 20474$ corresponds to the wave-length λ4884·2, and I could get no such line in the coronal spectrum.

DATTATRAYA SHRIDHAR JOG.
Physics Department,
Allahabad University.

Aspects of Fossil Botany.[1]

By Dr. D. H. SCOTT, F.R.S.

I. FERNS AND SEED FERNS.

THE fact that many of the well-known fern-like fossils of the Carboniferous formation were not ferns at all, but true seed-bearing plants, has long been familiar to students of palæobotany. It is a quarter of a century since the recognition of the seeds of *Lyginopteris oldhamia* by Prof. F. W. Oliver first led to the institution of the class Pteridospermeæ, or, in popular language, seed ferns. Yet, after this lapse of time, and in spite of all the attention given to the subject, much still remains obscure. We are still ignorant of the relation between true ferns and seed ferns, either as regards their respective importance in Carboniferous times, or the degree of affinity between them.

The early discoveries, in *Lyginopteris*, *Neuropteris*, *Aneimites*, and *Dicksonites*, cast doubt on such extensive groups of supposed ferns, that the impression was soon created that a majority of the Carboniferous 'ferns' were, in reality, seed-plants. At the present time even the great tree-ferns, the so-called Marattiaceæ of the Coal-measures, are called in question: Were they ferns or Pteridosperms?

Since the original discoveries of 1903–5, a number of additions have been made to our knowledge of seed-bearing plants of fern-like habit. Cases of direct continuity of seed with frond have been demonstrated in a further species of *Neuropteris*, in a *Sphenopteridium* and in a *Sphenopteris*, the two latter of Lower Carboniferous age. Prof. Halle, in his important investigation of the fossil flora of China, has already discovered five new cases of the kind, in the Permo-Carboniferous beds of the Province of Shansi, in northern China. One of his discoveries must be specially considered, for it has a direct bearing on the position of the supposed Marattiaceæ of the period.

The plant is *Pecopteris Wongii* (named after a Chinese colleague). There seems to be no doubt that one seed at least is attached to the rachis of the frond, while others are so grouped as to suggest a connexion. The seed is an ovoid body about 7 mm. in length. The case is a critical one, for the new species is almost identical with the well-known *P. Miltoni*, which has the fructification of *Asterotheca* and is therefore referred to Marattiaceous ferns. If it were positively known that *P. Wongii* bore the sporangia of *Asterotheca* as its male organs, the new species would afford the strongest evidence in favour of the transference of the Carboniferous 'Marattiaceæ' to the Pteridosperms.

In *Nystroemia*, a new genus, both sporangia and seeds were found, on distinct specimens, almost certainly belonging to the same plant. This plant thus appears to be one of the rare and fortunate instances in which both sexes are known in the same Pteridosperm.

[1] Based upon a short course of lectures delivered at University College, London, last autumn.

The most important, however, of the new Pteridosperms is undoubtedly the American genus *Eospermatopteris*, described by Miss Goldring. It is of Upper Devonian age, and is thus the oldest known seed-bearing plant. To avoid repetition, *Eospermatopteris* will be considered in the following article, devoted to early floras.

The male or pollen-bearing organs of the Pteridosperms are of special importance in the present survey, for it is chiefly on them that the comparison with the contemporary tree-ferns, the so-called Marattiaceæ, depends.

The original discovery, by Kidston, of the *Crossotheca* fructification of *Lyginopteris* is well known. The fertile pinnules are oval leaflets bearing pendulous sporangia or pollen-sacs on their lower surface. The peculiar feature is the bilocular structure of each pollen-sac, a point difficult to demonstrate in the imperfectly preserved material. Indirect confirmation is, however, afforded by clearly bilocular sporangia observed by Prof. Oliver in petrified specimens of other fructifications. Some doubt has been cast on the identification of the frond; Zeiller, however, accepted it as the foliage of *Lyginopteris*. The genus *Telangium*, founded by Dr. Margaret Benson, differs from *Crossotheca* in the sporangia standing erect on the end of the stalk, instead of being pendulous. Dr. Benson thought that her species, *T. Scotti*, was the male fructification of *Lyginopteris oldhamia*. It may have belonged to some allied plant, but the sporangia are not bilocular. Various other fructifications, preserved in the form of impressions, have been referred to *Telangium* and regarded as the male organs of Pteridosperms.

Our knowledge of the supposed male fructifications of seed-ferns is often unsatisfactory, owing to the obscurity of fossils preserved as structureless impressions. Kidston's case of *Neuropteris Carpentieri* is one of the best, for here the fertile pinnules are on the same frond with the sterile leaflets, differing somewhat from them in shape. The densely packed sporangia contain a quantity of spores—no doubt the pollen-grains. In *Potoniea* the large orbicular discs have been shown to bear sporangia. This genus probably represents the male fructifications of species of *Neuropteris*.

It may be said that the polliniferous organs of the Pteridosperms, where known, are almost constantly borne on specially modified pinnules or on a naked rachis. The only case in which they have been found, as it appears, on the unaltered frond, is that of *Dicksonites Pluckeneti*, to which we shall return.

It has hitherto been generally assumed that there existed, in Carboniferous and Permian times, a considerable body of true ferns, side by side with the Pteridosperms, or seed-plants of fern-like habit. The true ferns were regarded as including three groups, the Primofilices, the great tree-ferns of the

Upper Carboniferous, and a few others, such as the Permian Osmundaceæ.

The Primofilices are undisputed, and so are the Osmundaceæ of the late Palæozoic. The great problem is that of the tree-ferns commonly referred to the Marattiaceæ. These plants had tall stems, reaching at least 60 feet in height, clothed with a felt of descending roots. The highly compound fronds were of the *Pecopteris* type, resembling species of *Cyathea* among living ferns. The stems, known as *Caulopteris* or *Megaphyton* by their external features, as *Psaronius* when the structure is preserved, bore the large and conspicuous leaf-bases, and had a completely fern-like anatomy, usually with many concentric steles. There is a general, though not an exact, anatomical resemblance to the recent Marattiaceæ, and this is also shown in the polyarch roots.

The fructifications, in most cases borne on the underside of the fronds, are also Marattiaceous in type, the sporangia of each group being united together in various degrees, to form synangia. In most of the genera the sporangia are grouped about a centre, the synangium thus being more or less circular, as in the recent *Kaulfussia*. In *Ptychocarpus* they are completely united, and so also in a genus *Cyathotrachus*, discovered by Prof. Watson. In *Asterotheca*, of which many species are known, the sporangia are only slightly connected at the base, and the synangia are seated directly on the frond. In *Scolecopteris* the arrangement differs in the fact that the synangium (of four or five sporangia) is borne on a definite pedicel. In *Acitheca*, often included under *Scolecopteris*, a pedicel is present, but the sporangia are not seated on it but merely fixed around it.

I have recently observed a new species of *Scolecopteris*, and propose to name it *S. Oliveri*, after Prof. Oliver, who brought the material in which the specimens occurred from Autun. The sporangia are elongated, regularly four in each synangium; the most characteristic feature of the new species is that each fertile pinnule is immediately subtended by an apparent sterile pinnule, exactly fitting on to its lower side. It is probable that the two bodies are parts of one and the same pinnule, strongly incurved on itself.

So far, everything in these plants seems fern-like and much suggests the Marattiaceæ. Yet the highest authority, Dr. Kidston, in his latest work, expressed grave doubts as to the nature of this group. His opinion is stated in his great series of memoirs on the "Fossil Plants of the Carboniferous Rocks of Great Britain," which were in course of publication at the time of his death. In his first memoir, Dr. Kidston was still inclined to accept the current view, for he then thought it tolerably certain that the typical Pecopterids, with exannulate sporangia united into synangia, were ferns (Part 1, p. 17; 1923). In a later memoir, issued the same year, his tone is more doubtful, but he still allowed that *Asterotheca* and probably a few other Carboniferous plants that bear exannulate sporangia "may be Marattiaceous" (Part 4, p. 277). In the next memoir Dr. Kidston left the systematic position of *Asterotheca* an open question, but added: "The generic differences which separate *Scolecopteris* from *Asterotheca* are those of degree rather than of structure. The former genus I believe to be more probably a Pteridosperm than a fern" (Part 5, p. 483; 1924). Thus one important genus was already given up, and it was becoming clear that its companion must follow. Lastly, in the final memoir so far issued, Dr. Kidston stated that the affinities of *Acitheca* seemed to him to be Pteridospermous, and if so, that he could not see on what grounds *Asterotheca* and *Scolecopteris* could be excluded from the Pteridosperms. "It would therefore appear that the evidence in support of the occurrence of Marattiaceous Ferns in Carboniferous times rests on supposition, rather than on satisfactory proof" (Part 6, p. 538).[2]

We thus have to face the question whether true ferns (apart from the special group of the Primofilices) existed in the Carboniferous period. We can come to no conclusion, but may briefly sum up the arguments on either side. In favour of fern-affinities of the plants in question we have:

(1) The habit (unimportant, for undoubted Pteridosperms are just as fern-like); (2) the fructifications, almost the same as in living Marattiaceæ, and, as in them, usually borne on the ordinary frond; (3) the anatomy of stem and root, both altogether like that of ferns, and especially of Marattiaceæ.

Thus, in every respect, these Carboniferous plants appear like ferns. But the following are the arguments on the Pteridosperm side:

(1) The resemblance of the synangia of these plants to those of *Telangium*: this appears to be the point which chiefly influenced Kidston, *Telangium* being regarded as the male fructification of certain seed ferns; (2) *Crossotheca*, known in one case to have been the male fructification of a Pteridosperm, also occurs on Pecopterid fronds; (3) *Dicksonites* (=*Pecopteris Pluckeneti*), once universally accepted as a fern, probably Marattiaceous, is now known to have been a seed-bearing plant; (4) the instance of *Pecopteris Wongii*, already discussed, may prove to be conclusive, but the case is not yet closed.

Dicksonites is at present the only plant of the so-called Marattiaceous group which has been definitely proved to be a Pteridosperm. It is therefore of critical importance. The pollen-bearing organs are somewhat obscure. They appear to have been borne on the ordinary leaflets and to have consisted of tufts of sporangia, which Kidston compared to the synangia of *Telangium*. It would be of the utmost value to learn the anatomy of *Dicksonites* to compare with that of *Psaronius*, the type of stem referred to the 'Marattiaceæ.' In the absence of such knowledge, a comparison of the cuticular structure might throw light on the question. If *Dicksonites* showed complete agreement with the remaining "Marattiaceæ," we could scarcely doubt that all alike were Pteridosperms. This, however, is not yet proved.

In the meantime, an anatomist must continue

[2] Parts 5 and 6 were issued posthumously.

to be influenced by the old anatomical evidence from the completely fern-like structure of the *Psaronius* stems and roots. If *Psaronius* belonged to seed-plants, comparative anatomy would be discredited. Yet it has proved its value, for it was anatomical data which first put us on the track of the Pteridosperms, before the seeds were discovered.

The question of the evolutionary relations of the Pteridosperms, whether they were "ferns which had become Spermophytes" or an independent line of descent, cannot be settled until we know whether the tree-ferns of the Carboniferous were ferns indeed or seed-plants simulating them. A seed-bearing *Psaronius* would go far to resuscitate the former hypothesis, which of late years has seemed the less probable of the two. No such case, however, is as yet demonstrated. The whole question is in urgent need of further investigation.

Geometrical Art in South-east Europe and Western Asia.

By Prof. JOHN L. MYRES.

BETWEEN the vivid naturalism of Minoan art, the mature style of Crete and the South Ægean in the later Bronze Age, and the serene idealism of Hellenic art, in the great centuries from the sixth to the third, intervenes a style profoundly contrasted with both, popularly known as the Geometric Style of the Early Iron Age. It inherited something from Minoan art, and contributed more than appears at first sight to Hellenic; but in its maturity it was the negation of all that either Minoan or Hellenic craftsmen aspired to express. Such a group of facts, or sequence of events, presents a problem as fully worthy of scientific treatment as any crisis in geology or natural history: the problem, namely, of the apparitions and disappearances of geometrical art in the lands around the Greek archipelago. For the geometrical art of the Early Iron Age was not the only such occurrence; and its significance is best appreciated by comparison with other geometrical styles.

What we call style is approximation to a standard of achievement; and perfection of style is beauty in art. Geometrical styles come into being in various ways. In primitive Crete, as in other parts of the Mediterranean, vessels of clay were decorated with ornaments which were linear because incised, and rectilinear because they imitated basketry. Such skeuomorphic ornament is not 'geometrical' so long as its imitative intent is obvious; it becomes so as this intent is superseded by appreciation of the linear designs as pure forms and spatial constructions. Before this stage was reached in Early Minoan art, these linear designs were superseded by more or less naturalistic representations of plants and animals, scarcely restricted at all except by the surface of the decorated object.

Similarly, the painted pottery of Thessaly, probably derivative from a widespread Ukrainian culture between Danube and Dnieper, is decorated with lines and bands the prototypes of which—textiles or leatherwork—are uncertain, but the application of which, with utter disregard of the forms of the vessels, is the antithesis of early Ægean 'skeuomorphs.' This primitive style also perished early (with one possible exception) in conflict with the paintless 'gray-ware' of Orchomenus, and the almost paintless 'smear-wares' (*Urfirniss*) of the Greek mainland.

East of the Ægean, in the heart of Asia Minor, another painted linear style, still imperfectly known, influenced Syria and Cyprus late in the Bronze Age. It may be connected either with the Ukrainian culture or with that of Susa and other sites in the Persian hills and early Babylonia. It does not, however, seem to have affected the coast cultures of the Ægean until the Early Iron Age, and even then but slightly.

After great naturalistic achievements, Minoan ornament declined into mechanical and conventional abbreviations, and broke up into numerous local schools, during the troubled centuries from 1400 B.C. to 1100 B.C. or later; and it is as the sequel to this artistic collapse that the Greek geometrical style comes into being. It has been commonly supposed that the new style was introduced into Greek lands by 'northern invaders' from beyond the Danube, or at all events from Danubian countries. But recent discoveries, especially in Macedonia, have shown that, though an invasion occurred about 1100 B.C., its range was restricted, its effects were transitory, and the culture it introduced temporarily had no geometrical elements, other than a fondness for compass-drawn concentric circles, which had a fairly wide vogue in the mature geometrical repertory of the Ægean, and a far more general popularity in the contemporary art of Cyprus, where there is some reason to suppose that it arrived overland through Asia Minor from the same south-east European source. A second suggested source for the geometrical style of the Ægean is in certain scattered and belated survivals akin to the primitive Thessalian decoration, which have been detected in north-western Greece: and as the 'Dorian' invaders of peninsular Greece were traditionally derived from this region, these may represent the decorative style which they had before they came south.

It is difficult, however, to reconcile this explanation either with the sequence of styles in stratified deposits at Sparta, the most purely Dorian state in historic Greece, or with the geographical distribution of more or less geometrical styles in the South Ægean, or (most significant of all) with the very early and emphatic outbreak of geometrical art in Attica and its neighbourhood, which traditionally had been the refuge and rallying ground of non-Dorian and pre-Dorian elements from all parts of the invaded area. That the colonies propagated

[1] Summary of a discourse at the Royal Institution on Friday, Feb. 1.

overseas by these 'Ionian' refugees in conjunction with inhabitants of Attica itself did not share in that geometrical outbreak, is explained if it occurred after their founders had left Attica; and this is in accord with the contrast between Ionian and Attic types of safety-pin, and other elements of culture, and the similarities between Attic safety-pins and those of other districts where geometrical styles were established more or less effectively. Provisionally, therefore, the geometrical style may be regarded as an indigenous and local creation of that area of east central Greece where the disturbance and intermixture of older elements in the population seems to have been most intense; and as the artistic expression of the view of life enforced by the stresses of that crisis.

Characteristic of all geometrical art is the abstract quality of its ornaments: they represent no longer, nor even symbolise, any natural object, but have value through their mere forms or the relation which these forms bear to other forms which comprise them. Frequently an ornament and its background counterchange their functions; and secondary patterns emerge, such as the 'key-fret' and 'wave-coil,' wherein it cannot be said that there is neither design nor background, but only a positive and a negative element—for example, a black and a white—the combination of which *is* the pattern. In this aspect the Greek geometrical style was not so much a tradition as an invention; the first self-conscious, rationalist style in the history of art. The mere surface of the object, at the frontier between being and not-being, *plenum* and void—the form of the object, in complete abstraction from its substance—becomes itself the subject of artistic treatment; anticipating, and perhaps preparing the way for, the philosophical treatment of the same antithesis between form and substance.

A second characteristic is the rhythmical quality of the means employed to distinguish part from whole—the 'many' from the 'one' which they constitute—and attention is directed to the relation between the geometrical art of early Greek craftsmen—including the temple-architects—and the metrical inventions of epic and lyric poetry, the only other aspects of the higher life of that age which have been preserved.

Thirdly, the geometrical experiments in composition and artistic structure in two dimensions (whereas the frieze compositions of the Near East and Asiatic Greece, however elaborate, were essentially in linear series) initiates the progress of Attic and Argive schools of design, of architecture, and eventually of sculpture towards the ideals so nearly attained in the sixth and fifth century: to types of literary compositions best illustrated by Attic tragedians and the fifth century historians; and to remarkable experiments in political reconstruction of certain Greek city-states, and philosophical analysis of the structure of society and of Nature itself.

An Epic of Fastness.

MR. JAMES MORTON is an artist, an enthusiast, and a man of imagination, and yet he has chosen to be a textile manufacturer. With such a combination of qualities, there is little wonder that within scarcely more than two decades he has been responsible for an amazing change in the standard of colour fastness as applied to woven fabrics. More than to any other man do we owe it to him that to-day the colours of our fabrics are as sound and as permanent as the fibres of which they are made. The story of this development and that of the necessary dyes is unfolded in simple and almost poetic language in a paper read recently before the Royal Society of Arts[1]; it is one which should be read by every student of the present generation as worthy of ranking with similar stories of the great achievements of inventive industry in the past.

It was in 1902 that Mr. Morton, whose firm were makers of high-class furnishing fabrics, was impressed by the fugitive nature of the colours used, and in consequence was led to make exhaustive fading tests on coloured textiles from every source. The uniformly adverse result of these was staggering. It led Morton to institute a constructive campaign which has definitely left a permanent impression on the textile trade of the world. The scheme was to arrive at a range of colours, however small, from which fabrics could be prepared and guaranteed against fading from sunlight or ordinary washing. These, under the descriptive name of 'Sundour' fabrics, were first distributed by Messrs. Liberty in 1904. The early palette had a modest range of colours; it was greatly helped by the discovery in Germany of the first of the indanthrene vat colours about this time, whilst, in turn, the scope for these vat dyes was greatly increased by the market which the 'Sundour' fabrics had helped to create for them.

By 1914 the fadeless fabric business was firmly established with a world-wide reputation, when on the outbreak of War the manufacturers found themselves suddenly deprived of the supply of German dyes. How Morton first visited other dye-making concerns to learn their intentions in regard to the vat colours, and how he eventually set to work to make indanthrene blue and yellow for himself, must be read in the original paper. Such dauntless energy as he displayed was bound to succeed, particularly when coupled with a full and proper appreciation of scientific research. Next followed the manufacture of Solway Blue—the fastest of the acid wool colours—and then in 1919 Morton returned from having established his dye processes in America with the British rights of the air oxidation process for the manufacture of phthalic anhydride from naphthalene. He tells how his chemists did not at first value this, but that during the slump in 1920 and 1921, following the Sankey judgment which so nearly destroyed the infant dye

[1] History of the Development of Fast Dyeing and Dyes. A paper read before the Royal Society of Arts on Wednesday, Feb. 20.

industry, time was available to study its properties more fully. As a result the conversion of the anhydride into benzoyl benzoic acid and the transference of this into anthraquinone intermediates was discovered and the way was open to make these derivatives purer and cheaper than before and, indeed, to effect a revolution in the making of vat dyes. The greatest of all new discoveries arising out of this has been that of Caledon Jade Green, which is the only pure green of the anthraquinone vats and is further the fastest all-round colour of the whole vat series.

Doubly interesting to us now is the palette of the fast colours, for every one of them is full of the intensest new meaning. Using Mr. Morton's own words, "it tells of long arduous research, of high pressures and high temperatures, things attempted and done; it tells also of things yet to do that are full of hope and adventure which, after all, is real life."

We have seen in this brief outline how the desire to make the colours worthy of the designs they interpret and of the threads on which they are dyed, has led to the entry of a man, himself not a chemist, into the difficult field of making, under the handicap of war conditions, not only known dyes of great complexity, but ultimately of leading the world in the production of new dyes of greater fastness than any yet known. A singleness of purpose has characterised his effort throughout, thought of material gain has been remote, though we believe Mr. Morton has earned the greatest of all rewards, that of satisfaction.

Truly a worth-while story! E. F. A.

Obituary.

SIR HERCULES READ.

BY the death of Sir Hercules Read, which took place suddenly at Rapallo on Feb. 11, the world of archæology loses one of its most notable personalities. Possessed of an extraordinarily wide range of knowledge, he was recognised as a foremost authority in ethnography, in archæology, especially prehistoric archæology, and in fine art. His striking appearance and his charm, especially in presiding at a meeting or in addressing an audience, won him a wide circle of admirers. His qualities of character secured him many firm friends.

Charles Hercules Read was born on July 6, 1857, and was therefore in his seventy-second year. Becoming closely associated with Sir Augustus W. Franks at an early age, he joined the staff of the Department of Antiquities of the British Museum in 1880. Franks was then keeper of that Department, and on his retirement in 1896, Read succeeded him, becoming his residuary legatee on his death in the following year, and contributing his biography to the "Dictionary of National Biography."

Franks had contributed generously from his private resources to the national collections. They were no less indebted to Read, though his personal benefactions were on a smaller scale. He had the gift of informing with his own enthusiasm the group of wealthy men with whom he was closely in contact, and who benefited by his wide knowledge and taste in forming their own collections. It was through him that the little coterie known as "Friends of the British Museum" was formed, ultimately growing into the National Arts Collection Fund. Through this group many priceless objects were acquired for the national collections which otherwise would have gone to America. Among major acquisitions through his influence were the Waddesdon Bequest (collection of Baron Rothschild) in 1898, the Greenwell Collection of Bronze Age antiquities purchased by J. Pierpont Morgan in 1909, the bequest of painted enamels of the Rev. A. H. J. Barwell in 1913, and the plaquettes given by Mr. T. Whitcombe Greene in 1915. If Read's own gifts to his Department were less conspicuous for their pecuniary value, they were distinguished by the taste and judgment with which they were selected, especially where objects of Eastern art were concerned. These same qualities were exhibited in the formation of his own private collections, and justified the prices realised when they were dispersed a few years ago.

Read's activities were not confined to the Museum. He was secretary of the Society of Antiquities from 1892 until 1908, and twice president of the Society, first from 1908 until 1914, and then from 1919 until 1924. In this capacity he was *ex officio* a Trustee of the British Museum, an office which might have entailed some difficulty had it not been for his correct and tactful attitude. He was president of the Anthropological Section of the British Association when it met at Dover in 1899, his address putting forward a suggestion for the foundation of an Imperial bureau for anthropology, which was perhaps one of his most momentous public pronouncements. He was also president of the Royal Anthropological Institute from 1899 until 1901, and again during the War from 1917 until 1919. He was president of the India Society. He retired from the British Museum in 1921, when a dinner was held in his honour, at which a volume of essays by his friends was presented to him. It was illustrated by his portrait from a drawing by Seymour Lucas, R.A., and 55 plates showing the most important and beautiful objects of art and antiquity acquired by his Department during his keepership.

Neither Read's inclinations nor his qualities led him in the direction of the writing of books. He was more at home in the delicate delineation of the distinctive qualities of objects of art or the discrimination in subtle lines of argument as to evidence of provenance which appeal to experts. Hence his literary contributions to knowledge appear in journals such as *Archæologia*. He was also, however, the author or part author of the guides to the archæological collections of the Museum, the early editions of which appeared directly under his inspiration. As one of the most active members of the Burlington Fine Arts Club, he took a large

part in organising the well-known exhibitions held by that body.

Read received the honour of knighthood in 1912. He was an LL.D. of St. Andrews, was elected to the British Academy in 1913, and had received honours from learned societies in nearly every country in Europe as well as the United States. He was buried at Rapallo.

MR. T. H. BLAKESLEY.

MR. THOMAS H. BLAKESLEY died on Feb. 13 at eighty-one years of age. To the older generation of physicists and electrical engineers he was well known. Much of his work has formed the foundations of great practical and theoretical developments which the younger generation accept with but little, if any, thought of the pioneers who initiated researches the results of which are affecting the everyday life of almost every nation.

Blakesley was the son of the Very Rev. J. W. Blakesley, Dean of Lincoln, and was educated at Charterhouse and King's College, Cambridge, where he graduated as a wrangler in 1869. He first went to Ceylon as an irrigation engineer, and then in 1885 he was appointed instructor in physics and mathematics at the Royal Naval College, Greenwich. In that year Blakesley published his classical work entitled "Papers on Alternating Currents of Electricity." In this treatise he gives many fundamental theorems. In particular, he describes how to measure alternating current power by means of his 'split dynamometer.' He describes fully how phase difference can be determined, and gives for the first time many of those geometrical methods of discussing alternating current problems which are now in everyday use all over the world. He made valuable contributions also to the mathematical theory of the transmission of electric power by cables and to long distance telephone working. In this connexion he recognised the importance of the hyperbolic functions and computed tables of their numerical values. The value of this work was appreciated by experts at the time, and translations of it were published in Germany, France, and Russia.

Blakesley was also greatly interested in the reform of the teaching of geometrical optics, and used to point out to his friends with great animation the 'absurdity' of some of the definitions of focal lengths, etc., then in vogue at Cambridge. His book on "Geometrical Optics" appeared in 1903. The principles, however, of his proposed reforms in optics he gave in a paper to the Physical Society of London in 1897. His paper to the same Society in 1907 on "Logarithmic Lazy-tongs and Latticeworks" was of a type which would have been much more appreciated by mathematicians of an earlier generation who liked 'mathematical recreations.' His synthetic spectroscope was a colour mixer of a refined type superimposing three homogeneous portions of the spectrum in one picture. An instrument of this type was presented to Finsbury Technical College by the Mercers' Company, of which Blakesley was master in 1902 and 1903.

Blakesley did good work as honorary secretary of the Physical Society of London for several years. For much of its success and present prosperity the Society is largely indebted to him. He did a great deal to encourage the friendly co-operation of academic lecturers with research physicists employed in industry which is greatly to their common benefit. He will be sadly missed by his friends.

MR. ABEL CHAPMAN.

SINCE his first work, "Bird Life of the Borders" appeared in 1889, and by its vigour, direct and humorous description, and evidence of close observation, gained the ear of the public, Mr. Chapman published many accounts of his travels, all equally robust and all equally popular. He was a sportsman-naturalist of the best type, as keen to note the ways of his quarry as to secure a trophy, and never likely to be led astray by the theories of professional scientific workers, whom, in a general way, he despised. His own theories, upon such subjects as the migration of birds and protective coloration, he defended with abundant confidence and even obstinacy, but they suffered from a lack of knowledge of the investigations of other workers in the same field.

Mr. Chapman's home at Houxty, in Northumberland, set in the heart of the Border country, afforded him fine opportunities of bird-watching, and his penultimate work, "The Borders and Beyond" (1924), like his earliest, dealt mainly with the natural history problems of his immediate surroundings. But he followed Nature far afield, and his hunting expeditions in Spain, Norway, East Africa, and the Sudan produced a series of interesting books, full of acute observations: "Wild Spain" (1893) and "Unexplored Spain" (1910), "Wild Norway" (1897), "On Safari in British East Africa" (1908), and "Savage Sudan" (1921). In 1896, with Mr. W. J. Buck, he published "The Art of Wildfowling." Only last year his final work appeared, "Retrospect," an autobiographical survey written with the old combativeness and reviewing the more interesting observations of his fifty-four hunting trips and home experiences.

Mr. Chapman was born in 1851 and educated at Rugby. He died at Houxty on Jan. 23, at the ripe age of seventy-seven years.

WE regret to announce the following deaths:

Surgeon-Capt. E. L. Atkinson, D.S.O., parasitologist to Scott's last Antarctic expedition (1910), on Feb. 20, aged forty-six years.

Dr. Harrison G. Dyar, custodian of Lepidoptera in the United States National Museum, a leading authority on American mosquitoes, on Jan. 22, aged sixty-two years.

Mrs. Arabella B. Fisher (*née* Buckley), secretary for eleven years to Sir Charles Lyell, the geologist, and author of several popular works on general science, on Feb. 9, aged eighty-eight years.

Sir George Fordham, author of numerous papers on archæology, natural history, and other subjects, and of volumes on the history of maps and road-making, on Feb. 20, aged seventy-four years.

Commdr. Giovanni Roncagli, honorary secretary general to the Royal Geographical Society of Italy, on Feb. 1, aged seventy-two years.

News and Views.

THE Council of the Royal Society, at its meeting on Feb. 21, recommended for election into the Society the following fifteen candidates: Arthur John Allmand, professor of physical and inorganic chemistry, King's College, London; Arthur Henry Reginald Buller, professor of botany, University of Manitoba, Canada; Charles Drummond Ellis, university lecturer in physics, University of Cambridge; Ronald Aylmer Fisher, head of Statistical Department, Rothamsted Experimental Station, Harpenden; George Ridsdale Goldsbrough, professor of mathematics, Armstrong College, Newcastle-on-Tyne; James Gray (Cambridge), fellow of King's College and lecturer in comparative anatomy, University of Cambridge; Cyril Norman Hinshelwood, fellow and tutor of Trinity College, Oxford; Augustus Daniel Imms, head of Entomology Department, Rothamsted Experimental Station, Harpenden; Peter Kapitza, assistant director of magnetic research, Cavendish Laboratory, Cambridge; William Dickson Lang, keeper of the Department of Geology, British Museum; John Mellanby, professor of physiology, University of London; Henry Stanley Raper, professor of physiology, University of Manchester; Harry Ralph Ricardo, consulting engineer; Harold Roper Robinson, professor of physics, University College of South Wales, Cardiff; Frederick William Twort, professor superintendent of the Brown Animal Institution, London.

THE place taken by some of the best of our English timbers and the increasing use being made in Great Britain of some of the finest quality Empire timbers is well shown in the great new building known as Imperial Chemical House, Millbank, London, a special view of which took place on Friday, Feb. 22. Amongst the English timbers used are walnut veneers, chestnut, oak, sycamore, lime, and holly. The Empire woods include Australian silky oak, Australian black bean, Rangoon teak, Indian laurel wood, British Columbian timber, Canadian maple, Canadian yellow pine, Canadian spruce, Tasmanian timber, and Honduras mahogany. Of the English timbers, the chairman's room is panelled with English walnut veneers which it is said could scarcely be equalled by any other walnut veneers in the world. Certain rooms on the same floor are panelled with English chestnut key-jointed centres, built-up plywood panels. The conference rooms are panelled throughout with English oak which is of a higher quality than the finest Austrian wainscot oak. The first floor conference room is panelled with Australian silky oak, a beautiful wood which should have a more extended use in England. Another conference room is panelled with Australian black bean, the wood of which has a very beautiful figure. This panelling has a Renaissance design.

THE whole of the skirtings in the new building which is to house Imperial Chemical Industries, Ltd., including nearly 2½ miles of corridors, and in all the rooms with the exception of the panelled rooms, are made of English sycamore. For the elaborate carvings in the Gibbons manner English limewood has been used, whilst English hollywood is employed for the inlaid work in certain bath and changing rooms and lavatories. For dormer windows, staircases, and doors, teak is the timber employed. The room to be used by Lord Reading, one of the directors, is panelled with Indian laurelwood, which shows the striking beauty of the unusual figure of this timber. British Columbian timber has been used for the parquet flooring in some of the stories, including the great refectory. Tasmanian timber is used in the basement, and Canadian maple for the flooring in the squash rackets and badminton courts. Certain of the panelled rooms in white wood have been made from the best Canadian pine. The backings for the best panels, such as the walnut veneers, etc., are made from Honduras and West African mahogany. Finally, the great flagstaff, nearly 90 feet high, is made of Canadian Pacific coast spruce. It will be apparent that this magnificent building provides an important object-lesson in the utilisation of some of the finest timbers in the Empire.

IT is satisfactory to note that the interest in the application of scientific methods to industrial problems is beginning to receive financial expression. It was announced a few days ago that the trustees of the estate of the late Mr. C. Heath Clark had decided to make a contribution of £10,000 to the National Institute of Industrial Psychology for the promotion of education in London. The problems connected with the application of psychology to industry fall into two categories: (*a*) Those that involve the application of already well-established generalisations to a particular problem; (*b*) those for which as yet no generalisation is known. Employers are often quite willing to avail themselves of the help of the Institute for problems of the first order, but seem to be either unable or unwilling to help in the solution of those of the second, for these involve the slow and laborious accumulation of data for which no immediate value can be assigned. It is therefore necessary, if research is to go forward, that there should exist some fund which can be applied to problems involving more detailed study.

THE Institution of Mechanical Engineers, before which Prof. A. S. Eddington recently delivered the Thomas Hawksley lecture on "Engineering Principles in the Machinery of the Stars," was founded in 1847 at Birmingham with George Stephenson as its president. Thirty years later its increasing activities led to its removal to London, and its present fine headquarters in Storey's Gate has been the scene of many notable gatherings. The president this year is Mr. R. W. Allen, of the Queen's Engineering Works, Bedford, while the president-elect is Mr. Daniel Adamson of Manchester. Its membership is more than 10,000 and its income about £30,000 per annum. It has initiated and carried out much important research work; it has representatives on numerous conferences, boards, and institutions; it maintains various provincial and overseas branches, and in conjunction with the Board of Education it conducts

examinations for National Certificates and Diplomas in Mechanical Engineering at more than one hundred technical schools and colleges. The Thomas Hawksley Lecture was founded by the late Charles Hawksley (1839–1917) to commemorate the centenary of the birth of his father, Thomas Hawksley (1807–1893), one of the most distinguished waterworks engineers of his time, who served as president of the Institution of Civil Engineers and of the Institution of Mechanical Engineers. One of the greatest works with which he was associated was the Lake Vyrnwy Scheme, North Wales, for the water supply of Liverpool.

One hundred years ago a young musician, Louis Braille, blinded at the age of three, overcame his difficulty by the invention of a system of six dots whereby it was possible to emboss music, literature, and numerals. Braille was born at Coupvray, near Paris, in 1809, and died in 1852, having been a pupil and for twenty-six years a professor in the Institution des Jeunes Aveugles at Paris. In connexion with the centenary of the invention, the National Institute for the Blind, which has issued millions of copies of music, books, etc., is appealing for funds for its work. The appeal is addressed primarily to musicians, and it is proposed to have a performance of Mendelssohn's famous "Hymn of Praise," written in 1840 in connexion with the erection of the monument to Gutenberg on the fourth centenary of the invention of printing. It is in this work that the words "The night is departing" occur.

The first public school for the blind was established in Paris in 1784, the first in England was that at Liverpool opened in 1791, and the first in London dates from 1799. That in Paris was founded by Valentine Haüy (1746–1822), the brother of the famous crystallographer René Haüy (1743–1822), and it was Valentine Haüy who began printing in embossed characters for the blind. Many men of science have suffered from blindness. Galileo and Euler became blind. Nicholas Saunderson, for a long time Lucasian professor of mathematics at Cambridge, was blind from the age of one; and H. M. Taylor, at the time of his death in 1927 senior fellow of Trinity College, Cambridge, did most remarkable work by translating mathematical volumes into Braille after he became blind at fifty-two years of age. The Belgian physicist Plateau became blind at the age of forty-two, but with the aid of his wife and son continued to carry on his work in physiological optics and molecular physics, and at the age of seventy-two published a valuable contribution to the knowledge of capillary attraction.

A new scientific expedition to the Antarctic under the leadership of Sir Douglas Mawson is now being organised. The *Times* announces that the British government has given the *Discovery*, and that the Australian government is providing the necessary funds. The government of New Zealand is also contributing. The expedition is designed to explore the region between the Ross Sea and Enderby Land and to continue the work carried out in that area by Sir Douglas Mawson and Capt. J. K. Davis in the Australasian Antarctic Expedition of 1911–14. Capt. Davis is again to go with Sir Douglas Mawson and will be in command of the *Discovery*. Much of the coast-line towards Enderby Land is still unknown, and Enderby Land itself has never been visited since its discovery in 1832. Aeroplanes will be useful for inland survey. The study of meteorological conditions will enable the relationships between the climates of Antarctica and Australia to be determined more accurately. Much attention will be paid to the distribution of whales, in view of the spread of commercial whaling to those waters. The expedition will sail from Australia towards the end of this year. The combination of aeroplane reconnaissance and detailed ground work should result in discoveries of the highest value.

A paper was read before the Surveyors' Institution on Feb. 4, by Mr. H. J. Vaughan, on "The Significance of the Timber Merchant in Estate Forestry." Mr. Vaughan, who is now managing a large estate, in addition to taking a keen interest in the planting and growing of trees, has had the somewhat unique experience of having spent two years in close association with a large firm of English timber merchants in the south of England. He says, in his opening paragraph, that "it seems to me that some even of our eminent foresters tend to lose sight of the saw-bench when advocating and putting into practice schemes of afforestation or re-planting." After glancing at the sporting and amenity aspects of woodlands, Mr. Vaughan pointed out that what the timber merchant wants is a regular and trustworthy source of supply of his raw material, and that the management of private woodlands in the past has not fulfilled this desire. This is the cause to some degreee of the low prices offered to owners for their trees, and for the high freights charged by railways for the carriage of timber. After contrasting some of our best hardwoods with the softwood conifers, Mr. Vaughan said he doubted whether Great Britain would ever be able to compete with the Scandinavian countries in this class of material. In discussing the work of the Forestry Commissioners and their concentration on planting softwoods and purchase of land for this purpose, Mr. Vaughan expressed the opinion that it would be better to concentrate on growing hardwoods wherever possible, some of our native trees of this class having a real superiority, rather than to try to meet a questionable world famine with what is bound to be a very small proportion of our total requirements of coniferous softwoods for building and for constructional work. Mr. Vaughan considers it a wrong policy to plant conifers on areas where valuable hardwoods would grow.

The Department of Entomology of the British Museum (Natural History) has recently received through Mr. P. A. Buxton, of the London School of Hygiene and Tropical Medicine, specimens of a new genus and species of parasitic Hymenoptera (Ichneumonidæ), bred from the grubs of *Cladocera migro-ornata*, a beetle used by the Bushmen of the Kalahari Desert, South Africa, as an arrow poison. The Trustees of the Museum have approved the purchase

for the Department of Geology of part of the skeleton of the horse-like mammal *Moropus*. This is one of the Chalicotheres, distantly related to the horses, which they resembled in their rather small head and long neck. The fore-limbs were long compared with the hind-limbs, so as to give the trunk a giraffe-like pose. Like the horses, they were herbivorous, but they had claw-like hoofs, three on each foot. Chalicotheres have been obtained from early Tertiary times onwards, from Europe, Asia, Africa, and America. Hitherto the Museum had only some incomplete remains from India, and a single claw from Central Africa. The individual now acquired came from the Middle Tertiary of North America. It stands as high as a large horse, but the bones are far more massive. Recent additions to the mineral collection of the Museum include some crystallised sprays of native gold in calcite from Torquay, Devonshire, discovered and presented by Prof. W. T. Gordon.

PROF. F. O. BOWER, F.R.S., made "The Evolutionary Relation of the British Ferns" the subject of his presidential address to the Yorkshire Naturalists' Union at York on Dec. 8. The address is published in full in the *Naturalist* for January 1929, and is of very great interest to British botanists, as the following citation will indicate: "Having this year completed nearly half a century's research on 'Ferns,' and summed it up in three volumes in which the aim has been to reconstruct their chief evolutionary sequences upon a foundation of Organography, it seemed not inapt to use the present opportunity for placing our British Ferns in their probable relation to the Class at large. I believe this has never yet been done." Both task and man were most apt to the occasion, a memorable one for the Union; a large meeting listened to a most delightful and stimulating address which did not restrict itself to the written word, but often diverged into a most interesting and relevant commentary upon the slides used in illustration, which were made from the plates of Sir William Hooker. Prof. Bower pointed out that in Great Britain we have only some forty species out of a total of 6000, but these are representative of half the families and about one-eighth of the genera. "This is probably the consequence of the position of Britain on the extreme fringe of a great continental area." Many of the largest fern genera are monotypic with us. Prof. Bower discussed this interesting fact, concluding that probably the majority of these British ferns "represent vestiges of a richer flora of the past, and that the species themselves have, by their more ready adaptation, or by more hardy constitution, been able to subsist in surroundings from which their congeners have retired beaten." "In fact, they symbolise the tenacious and adaptable race of men that inhabits these islands."

PROF. J. A. FLEMING gives interesting personal recollections of Sir Joseph Wilson Swan in the *Journal of the Institution of Electrical Engineers* for February in connexion with the invention of the carbon incandescent electric lamp. In particular, he points out that one of the carbon incandescent lamps shown by Swan at an Exhibition in Newcastle-on-Tyne on Dec. 18, 1878, is still preserved in the Science Museum at South Kensington. It is necessary to distinguish between patent priority, which is often a mere matter of luck or promptitude, and that scientific or technical priority which is based upon achievements, exhibitions, public statements, or the evidence of contemporary workers. Scarcely any invention springs into existence in full completion. In many cases inventors may with justice claim to have originated some part of an invention. It was thus with the invention of the electric lamp of small candle-power. The 'subdivision of the electric light' was the problem which the electricians of 1878 had to solve. In 1879, Fleming was scientific adviser to the Edison Telephone Co., and in 1882 he was appointed in the same capacity to the Edison Electric Light Co. and to the Edison and Swan Co. In his opinion the credit for the epoch-making invention of the electric lamp cannot be solely attributed to T. A. Edison. Sir Joseph Swan is, without doubt, one of those whose names are inscribed high up on the roll of fame. For all future time his name will be connected with the invention of the carbon filament electric lamp.

DURING the summer meeting last year at Glasgow of the Institution of Electrical Engineers, many members visited the works of the British Aluminium Co. at Tulloch and Fort William. The company has two hydro-electric stations in operation, that at Foyers on Loch Ness, opened in 1896, and a second at Kinlochleven, on Loch Leven, opened in 1909, while a third and much larger one is being erected about a mile from Fort William. This is not only of interest on account of its size and its various engineering features, but also as an example of the use of water-power for manufacturing in a remote area dominated by the mountain Ben Nevis. The most notable piece of construction has been the boring of the tunnel from the valve shaft at the Treig Dam to Fort William, 15 miles in length. Commenced in the summer of 1926, the last shot opening the tunnel was fired on Feb. 9, the work having proceeded from 23 faces by means of vertical shafts and horizontal adits. From the surge chamber on the hill above Fort William the water will be conveyed by three steel pipes, at a maximum head of 800 ft., to the power-house, which will eventually have turbines of a total capacity of 120,000 h.p. The catchment area is 303 square miles in extent, the rainfall over which varies from 50 inches per annum in the northern part to 160 inches on the summit of Ben Nevis. A short description and a map of this important scheme was given in *Engineering* for July 6 of last year. Though the tunnel is now bored, about half of it still remains to be lined with concrete.

THE Annual Summary of the World's Shipbuilding, issued by Lloyd's Register, is a statistical return of great value affording an indication of the progress of this great industry in all countries. The summary for 1928 deals with the ships launched during the year, their tonnage, classes, types and machinery, and includes tables showing the tonnage launched for many

years back. Shipbuilding is an industry liable to very great fluctuations, and one which, owing to the War, experienced great difficulties. The fluctuations will probably always occur, for the demand for ships varies with many factors, but it is a satisfactory feature of last year's return to find that the tonnage launched in Great Britain and Ireland was 53·6 per cent of the world's tonnage of about 2,700,000 tons. The tonnage launched in 1893 was about one million tons, in 1903 it rose to two million, in 1913 to three million, and in 1919 to more than seven million tons. Of this seven million tons about half was built in the United States, but after 1921 shipbuilding in the United States sank to a much lower level, and last year the tonnage launched in that country amounted to only 86,000 tons. The growth of the mercantile fleets of the world can be seen by comparing the total tonnage of 42,514,000 tons of 1914 with the 61,594,000 tons of 1928. Remarkable changes in ships have taken place also. Oil tank ships in 1914 amounted to 1,479,000 tons, in 1928 to 6,544,000 tons; motor ships totalled 234,000 tons in 1914, and 5,432,000 tons in 1928; while steamers fitted for burning oil totalled 1,310,000 tons in 1914 and 19,000,000 tons in 1928. The largest vessels launched during 1928 were the German Atlantic liners *Bremen* and *Europa*, of 46,000 tons each.

WE have received the first number of the *Journal of Nutrition*, edited by J. R. Murlin, assisted by an editorial board of ten well-known American experts in this branch of science. It is to be published every two months by the American Institute of Nutrition, the president of which is E. F. Du Bois; at present one volume of about 500 pages will be issued each year. The first number (September 1928) contains articles by H. M. Evans, "The Effect of Inadequate Vitamin B upon Sexual Physiology in the Male" and "Relation of Vitamin E to Growth and Vigour"; by E. V. McCollum and collaborators, "The Distribution of Vitamin E"; by B. Sure, "A Detailed Study of the Rôle of Vitamin B in Anorexia in the Albino Rat"; and by the editor, "Vital Economy in Human Food Production," etc., some of which we hope to refer to in more detail later. The *Journal* is well got up, with a portrait of Lavoisier on the cover, and is clearly printed. The science of nutrition has expanded so greatly in the last few years that there is undoubtedly room for another journal dealing solely with this subject; the composition of the editorial board should ensure that it maintains a high scientific outlook. It can be obtained in Great Britain from Messrs. Baillière, Tindall and Cox.

AN article on the marine biological laboratory at Seto, Japan, its equipment and activities, with remarks on the fauna and flora of the environment, appears in the *Memoirs of the College of Science, Kyoto Imperial University*, Series B, vol. 3, No. 3; 1927. The laboratory, which is affiliated to the departments of zoology and botany of Kyoto University, was opened in 1922. It consists of a number of separate buildings—an aquarium open to the public, a students' laboratory, two research laboratories, and a dormitory capable of accommodating thirty persons. Up-to-date equipment is installed throughout, and individual research rooms are furnished with electricity and running salt and fresh water. For the collection of material the laboratory possesses, in addition to three rowing boats, one vessel of 19 tons capacity, fitted with masts and sails and equipped with a 25 h.p. semi-Diesel gas engine. Up to the present the staff has been engaged mainly in making faunistic surveys of the various collecting grounds. A preliminary survey of the littoral and inshore areas has already been completed, but that of the deeper waters has not yet been fully worked out. Spring and summer vacation courses—attendance at which is compulsory—are provided for students of biology at the University, and a summer course is also provided for teachers of biology in public schools.

THE Report of the United States Coast and Geodetic Survey for the year ending June 30, 1928, in addition to the usual record of work, mentions several new features. The demand of air maps has led to a new branch of the department's work. Already several sheets of recognised flying routes have been published and others are in preparation. A big development in this branch of survey work is anticipated. In coast surveys considerable use is now being made of echo sounding with the fathometer, for which the claim is made that it allows work to be done twice as quickly as by any other means. It is now used in eight survey vessels which can work at full speed, and stop only when temperatures or water samples are required. In connexion with echo sounding, a further development is sound ranging in order to fix positions in thick weather. The use of this method allows hydrographical work to be continued almost regardless of weather conditions and throughout the twenty-four hours. The report gives a number of charts showing the state of field work up to the end of the year under consideration.

THE recent series of illustrated post cards of British trees issued by the Natural History Museum, as F 22—F 28, contain excellent photographs and illustrations of trees, long familiar in Great Britain, if not necessarily native. In each series two photographs show the appearance of a fine example of the tree in winter and in summer, whilst two more coloured illustrations depict and analyse flower and fruit. These cards, with their accompanying descriptive leaflet, together with an exhibit of British-grown trees in a bay in the Central Hall of the Natural History Museum at South Kensington, to which the leaflet refers the reader, should help to make the city dweller more alive to the beauty and interest of the trees of the countryside.

APPLICATIONS for the Government Grant for scientific investigations must be made to the clerk to the Government Grant Committee, Royal Society, Burlington House, W.1, upon the requisite form, by Mar. 31.

DR. KARL JORDAN, curator of the Entomological Department of the Zoological Museum at Tring, has been elected president of the International Commission

on Zoological Nomenclature, in succession to Prof. F. C. Monticelli, deceased. Prof. Fillipo Silvestri, of Portico, Italy, has been elected a member of the Commission in succession to the late Prof. F. C. Monticelli, of Naples.

THE new-year issue of *The Fight against Disease*, the organ of the Research Defence Society, reminds us that the Society has now been in existence for twenty-one years. An interesting correspondence between Lord Knutsford and the Hon. Stephen Coleridge on diabetes and insulin treatment appears in this number.

A CATALOGUE issued by Mr. Francis Edwards, High Street, Marylebone, of books on the voyages of Captain James Cook, contains several items of great interest. One entry is the original painting by J. Webber, who was artist in the *Resolution*, of the death of Captain Cook in Hawaii. This picture is well known from the engraving by Bartolozzi. Another item is the manuscript log-book of H. Roberts, who as mate of the *Resolution* was in charge of the pinnace which took Captain Cook ashore for the last time. The log runs from October 1778 to November 1779, when Capt. King demanded for the Admiralty all log-books and diaries kept on board the ship.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—An assistant in the Electrical Engineering Department of the Coventry Municipal Technical College—The Director of Education, Council House, Coventry (Mar. 8). A head of the Building Department of Rutherford Technical College, Newcastle-upon-Tyne—The Director of Education, Northumberland Road, Newcastle-upon-Tyne (Mar. 9). A head of the Engineering Department of the Technical Institute, Gillingham—R. L. Wills, 15 New Road Avenue, Chatham (Mar. 9). A woman lecturer in education in the Department of Education of the University of Bristol—The Secretary, Department of Education, The University, Bristol (Mar. 11). A lecturer in engineering at the Technical College, East London, South Africa—The High Commissioner for the Union of South Africa, South Africa House, Trafalgar Square, W.C.2 (Mar. 12). A Tancred student in physic at Gonville and Caius College, Cambridge—E. T. Gurdon, 28 Lincoln's Inn Fields, W.C.2 (Mar. 12). A director for the Harcourt Butler Institute of Public Health, Rangoon—The Secretary to the High Commissioner for India, General Department, 42 Grosvenor Gardens, S.W.1 (Mar. 13). A professor of botany in the University of Birmingham — The Registrar, The University, Birmingham (Mar. 16). A horticultural lecturer and adviser under the Bucks County Council — The Agricultural Organiser, Education Sub-Office, Aylesbury, Bucks (Mar. 16). A professor of philosophy in the University of Lucknow—The Registrar, The University, Lucknow (Mar. 17). An assistant lecturer in economics in the University College of North Wales—The Registrar, University College of North Wales, Bangor (Mar. 18). An assistant inspector in connexion with agricultural and horticultural education and research—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (Mar. 18). A lecturer in metal mining in the Mining Department of the University of Birmingham—The Secretary, The University, Birmingham (Mar. 23).

ERRATUM.—Obituary of Dr. J. W. L. Glaisher in NATURE of Jan. 26, p. 135, col. 2, line 8 from bottom : for 1910 read 1901.

Our Astronomical Column.

SPECTRA OF MINOR PLANETS.—*Lick Observatory Bulletin*, No. 407, contains an investigation of this subject by Mr. N. T. Bobrovnikoff ; he used a one-prism spectrograph on the 36-inch refractor. As might be expected, the light of the small planets is wholly reflected sunlight ; there are no absorption bands as in the giant planets. The violet and ultra-violet regions are generally very weak as compared with the spectra of *G*-type stars. There is evidence of difference of composition of different planets ; thus Ceres is bluer than Vesta, the maximum of intensity of the latter being much further towards the red end ; the values given are : Ceres, $\lambda 4800$; Vesta, $\lambda 5300$. It has been deduced both by changes of light and of spectrum that Vesta rotates in $5^h\ 55^m$. The suggestion is made in the article that minor planets may be comets that have lost their gaseous envelope ; but it should be remembered that Halley's comet was invisible when in transit over the sun in May 1910, whereas any solid body of even a few miles in diameter would have been detected, the comet being near the earth.

MAGNITUDES OF STARS IN THE CAPE ZONE CATALOGUE.—The importance of the accurate determination of magnitudes both for statistical purposes and for the deduction of spectroscopic parallaxes has been more fully realised during the last two decades. The Cape Observatory has lately published a volume which gives the photographic magnitudes of 20,843 stars in the Cape Zones (Declination $-40°$ to $-50°$), the Harvard spectral type and photometric and photographic magnitudes being given for comparison.

Very careful experiments have been made at the Cape of the photographic effects of different exposures, different intensities of light, and different brands of plates. Kron gave an exponential formula with different values of the exponents for different brands of plates. This is adopted with the simplification that Kron's a_1, a_2 are each assumed equal to 0·25 for all brands of plates. The quantity I, known as the 'optimal intensity,' is, however, considerably greater in slow than in fast plates. The mean difference (irrespective of sign) between Cape and Hertzsprung is 0·07 mag. ; the difference from Harvard for 16 stars in the south polar sequence is $+0·07$ mag.

The satisfactory conclusion is reached that if there is on a plate one star the magnitude of which is known from extraneous sources, the magnitudes of the other stars on the plate can be deduced. The zero point of the Cape system was derived from the Harvard visual system corrected for colour. There is found to be a marked tendency for the colour indices to group themselves round four maxima the positions of which are $-0·04$ mag., $+0·38$ mag., $+0·84$ mag., $+1·30$ mag. It will be seen that they are nearly equally spaced.

Research Items.

Dugong Fishing in Madagascar.—M. G. Petit publishes in the *Bull. et Mém. Société d'Anthropologie de Paris*, T. 8, Sér. 7, fasc. 4-5-6, some further observations on the ritual of dugong fishing in south-west Madagascar. Small light outriggers, extremely mobile, are employed, the fishermen being two in number to each, a harpooner who stands in the bow being in command. Before setting out, the harpooner consults the *Sitily* as to whether conditions are favourable, and he is provided with a talisman (*Ody*). This is used first to consecrate a vessel of sea water, and is then placed in the prow and covered with a piece of old net to protect it. The sea water is used to sprinkle the canoe, while invocations are addressed to it, and to the harpoon and its ropes. It is also used to wash the head and hands of the fishermen. As soon as the day for fishing has been fixed, the fishermen must abstain from all contact with their wives, and must not touch food prepared or water drawn by them. The fishermen are in fact in a magical state, of which the serious nature is indicated by the fact that to miss the dugong not only entails misfortune for the village, but will be followed by the death of a member of the fishermen's family. When the animal has been brought to land, its body is scrupulously hidden from the sight of women and children. The body is dismembered by an old man, and the blood carefully collected and divided into three parts, one poured on the sand by the canoe, one into the sea, and the third smeared on the prow of the canoe, the harpoon and the rope. The flesh is eaten on the beach, first by men and, when they are satisfied, by women and children, but no knife, fork, or other utensil must be employed, nor must anyone spit or blow the nose. The carcase must be buried, this being done with ceremony, as neither beast nor bird, but only man, must eat the flesh or pick the bones. If the animal is female, connexion is enjoined on the fishermen, a custom which is found on the east African coast, and in a Chinese account of the Aino of Sakhalin in relation to women-fish, presumably seals.

The Starling in the United States.—The European starling, set free in New York in 1890 and 1891, has since 1910 spread rapidly throughout the United States, so that it seems likely to colonise all the country east of the Rocky Mountains, and, should it pass the Continental Divide, to prosper also on the Pacific coast. With such an extension of range possible, it is important that the economic influence of the bird should be properly understood, and E. R. Kalmbach supplies the needed information in a U.S. Department of Agriculture *Farmer's Bulletin* (No. 1571, December 1928). His conclusion is that most of the starling's habits are either beneficial to man or of a neutral nature. Field observation has established the fact that the time spent by starlings in destroying crops or in molesting other species of birds is extremely short compared with the endless hours they spend searching for insects or feeding on wild fruits. It is admitted that the bird damages cherries and certain other small fruits, and that its roosting habits make it objectionable in cities, but it is claimed that these are the results of overabundance rather than pronounced tendencies for harm on the part of the individual bird. Such conditions are local and should be remedied by local control, such as the destruction of the roosts, or if that be not possible, by fumigation—a tricky and perhaps dangerous proceeding—or on a small scale by trapping.

Evolutionary Significance of Parasites.—Prof. R. Hegner (*Quart. Review Biol.*, **3**; 1928) discusses the protozoa found in man and in monkeys. He states that of the four genera of amœbæ that live in man, three are represented in monkeys and the fourth has probably not yet been discovered on account of its rarity. Four of the six well-authenticated species of human amœbæ are indistinguishable from four of the species found in monkeys. Among the intestinal flagellates of monkeys are five species that are indistinguishable from five of the seven species which live in man. The ciliate *Balantidium coli* which lives in man is probably the same species that has been recorded from various species of monkey. All three species of human trypanosomes seem to be present as natural parasites of monkeys, but the Leishmanias have not been reported from monkeys. Malarial parasites that occur in monkeys resemble the three species that live in man. Thus sixteen of the twenty-five species of human protozoa have been described from monkeys. One genus of ciliates (*Troglodytella*) and one *Babesia* occur in monkeys but not in man. Comparison of human protozoa with those of mammals other than monkeys shows that they can be distinguished without difficulty; for example, the intestinal amœbæ and flagellates of the rat and the rat trypanosome are not identical with any species of human protozoa. If the proposition is valid that close relationships of parasites indicate a common ancestry of their hosts, then the facts available furnish evidence of importance in favour of the hypothesis that monkeys and man are of common descent.

Fish Statistics from Latvia.—The Section of Fish and Fisheries Industries of the Ministry of Agriculture has continued its fish statistics for 1927 in Latvia (*Bulletin statistique des pêches maritimes de Lettonie.* Année 1927, Rédigé par V. Miezis, Riga, 1928). The report is in Latvian and in French. Tables are given relating to the various catches in the years 1924–27, for the months in 1927, giving the total weight in kilograms of the fish taken and their money value, the quantity of fish month by month in 1927 and according to districts, details of the boats and gear, number of fishing days, and the state of the fishing each month; also the number of seals killed is included (84 in 1927, mostly from the Kolkas region). At the end there is a useful list of the names of the fish in Latin, Latvian, French, German, and Russian. Herring form the largest part of the fishery, then flat fish, salmon and salmon-trout, cod and *Zoarces viviparus* being sometimes in greater numbers than the salmon. Sprat and eels are also caught. The herring fishery for 1927 is the largest of the four years, the other years in order being 1925, 1926 and 1924; the order for flat-fishes and turbot is 1926, 1925, 1924 and 1927.

Halogen Compounds and Toad Tadpoles.—Mr. Shinryo Ohfuchi describes the effect of chlorides, bromides, and iodides, and also of feeding with thyroid substance, on the toad *Bufo vulgaris formosus* ("Effect of Halogen Compounds on the Growth of the Tadpole of *Bufo vulgaris formosus* B." *Science Reports of the Tôhoku Imperial University*, 4th Series (Biology), Sendai, Japan, vol. 3, No. 4, Fasc. 1, 1928). The halogen compounds, sodium and potassium chlorides, bromides, and iodides, were mixed with the pond water in bowls, and algæ were given in every vessel. All the tadpoles were fed on cow's liver, except those fed on the thyroid extract. Liver and each culture medium, with algæ, were renewed every day. It was found that, in general, chlorides tend to accelerate the growth of the body at first, later to retard. Bromides

retard at first, later accelerate. Iodides retard the growth of the trunk and hind limbs but tend to increase the tail dimensions, thus indicating a longer period during atrophy of the tail. Metamorphosis is hastened by feeding with extract of thyroid, but potassium iodide in the water does not have the same effect.

MOLLUSCA FROM NEW ZEALAND.—Mr. A. W. B. Powell in two papers describes three new volutes and five new land shells from New Zealand (*Proceedings of the New Zealand Institute*, vol. 59, Part 2, 1928). The larger recent volutes of New Zealand are separable into two main groups, one occurring in shallow and the other in deeper water. Two of the new species belong to the first group, the members of which show much variation and are characterised by a projecting callus-plate on the columella, the deeper water species having none. The radula of the Volutidæ is of a simple degenerate type, but it is possible to detect slight differences in the single central tricuspid tooth which remains in nearly all species. These differences in shape of base and length of cusps help the author to separate the species, but as the teeth of the radulæ of other molluscs are known to be variable, it is well to be careful in attributing importance to these slight differences until many specimens have been examined. The land shells described in the second paper are interesting, but the shells only are described. *Murdochia aranea* is a beautiful little snail with delicate white riblets showing up on a reddish brown background. *Cavellia spelæa* is the largest species of the genus as yet found, measuring 5·25 mm. across. It is a sub-fossil species found in a cave together with *Moa* bones, and also with the common bush snail *Charopa coma*.

GROWTH REGULATING ACTION OF THE LEAF.—R. Dostál has of late years developed a theory as to the significance of the metabolism of the leaf as a correlating influence upon growth. Whilst some striking experiments have recently been described by this worker, in which the normal periodicity of scale and leaf production in the annual cycle of the leafy shoot of the tree has still been maintained under very exceptional external conditions, many of the experimental data which were associated with the development of this view will be found in a long paper published in the *Acta Soc. Scient. Nat. Moraviæ, Cechoslovakia*, **3**, 83-210, 1926. In general, his view is that the growth of the axillary or terminal shoot primordium is very much influenced by the metabolism of the subtending leaf, and he examines the various marked changes in development of the shoot that follow upon mutilation or other experimental modification of the normal activity of this leaf. He also analyses, in experiments with *Circæa intermedia* and *Scrophularia nodosa*, the different morphogenetic quality of different regions of a shoot, as exemplified by the different results obtained when similar regeneration experiments are carried out with isolated nodes from different regions of the same shoot.

GRASS FIRES AND PLANT SUCCESSION IN SOUTH AFRICA.—During the present year the vegetation of South Africa will have, perhaps, a special interest to many readers of NATURE, and attention may be directed to the memoirs on the Botanical Survey of South Africa, which are being issued by the Department of Agriculture under the general direction of Dr. I. B. Pole Evans, Director of the Botanical Survey. *Memoir* No. 12, recently issued, by Ernest E. Galpin, upon the Springbok Flats, raises in an interesting manner one very controversial South African problem—the practical significance of annual burning of grassland. Galpin's conclusion is that acacia trees will gradually spread over the whole Springbok Flats, so that the grassland will become more or less dense acacia scrub. The cause of this change of vegetation is traced in a large measure to the suppression of the custom of annual veld burning, as European methods replace traditional native ones. The soil probably increases in humus with the suppression of the fires, but if the result is too intractable acacia scrub, it may be unfortunate, and the traditional native practice of burning thus prove to be justifiable. On the other hand, on the poorer grassland of the neighbouring veld, which stands higher than the rich loams and fertile grasslands, burning seems to be a very harmful practice. The wind then catches the exposed surface of the sandy soil and carries it forward, so that the sand veld is encroaching on the richer cultivable land as the result of frequent fires. Galpin has described a very interesting and rare new plant, *Cucumis humofructus*, Stent, which buries its fruit in the ground as it ripens as the result of negatively geotropic growth curvatures in the stalk.

CHLOROPHÆITE AND PALAGONITE.—The discussion of the nature of these and related mineraloids and of the terminology to be applied in specific cases, is continued by Martin A. Peacock and R. F. Fuller in the *American Mineralogist*, July 1928, and by L. L. Fermor in the *Rec. Geol. Surv. India*, Part 2, 1928. Dr. Fermor presents a general formula—

$$2\tfrac{1}{2}H_2O\ .\ 5R_2O_3\ .\ 20SiO_2 + n(RO\ .\ H_2O) + (80 - 4n)H_2O$$

—representing a series in which not only chlorophæite and palagonite find a place, but also certain other amorphous or micaceous minerals. The two other authors claim that ferric oxide is strongly dominant in chlorophæite, whereas alumina is abundant in palagonite. The former they regard as a result of hydrothermal action on basic constituents of basalts and dolerites; whereas palagonite is interpreted as a gel produced by the hydration of sideromelane. They propose that sideromelane should be retained as a specific name for clear, pale-coloured basaltic glass, as distinct from tachylyte, which is deep brown, opaque, and even microscopically turbid. Fermor, advocating the view that palagonite falls within the chlorophæite series, naturally points out that the term chlorophæite has twenty years' priority, and should therefore be adopted as the mineraloid name. Palagonite, he thinks, should be used as a rock name, and sideromelane he regards only as a variety of tachylyte. Much of the existing confusion doubtless arises as a consequence of basaltic alteration products and mesostatial material having been called palagonite when terms like chlorophæite and delessite would probably have been more appropriate. Chlorophæite, in the sense of Peacock and Fuller, is now a well-established term, but palagonite can no longer be used without a careful explanation of what it is meant to imply.

ATMOSPHERIC OZONE.—The issue of the *Proceedings of the Royal Society* for Feb. 4 contains Dr. G. M. B. Dobson's third report of the work of himself and of his collaborators on the ozone of the atmosphere. In this they have been mainly concerned with the fluctuations of the ozone content in typical cyclones and anticyclones, and their extensive data are summarised in a convenient set of maps and tables which, apart from their intrinsic interest, should be of great value when they can be subjected to detailed analysis in conjunction with other meteorological records. Dr. Dobson has already found at least two important connexions with other phenomena. One of these, which was suspected previously, and has now been confirmed, is that there is a small but definite tendency for days with much ozone to be associated with

magnetically disturbed conditions. The other has been found by studying the ozone records in relation to the movements of the large air masses, as diagnosed by the Norwegian Meteorological Institute. It appears that polar air has a high ozone content and tropical air a low ozone content, and since the weather records are essentially obtained from data which refer to the troposphere, whilst the centre of gravity of the ozone layer is probably at a height of from forty to fifty kilometres, the ozone measurements thus give evidence that the large tropical and polar air currents extend to a great height and bring their own stratosphere with them. The study of cyclones and anticyclones has now been abandoned, as it is felt that further work in this field must be left to larger organisations, and the recording instruments have been sent to a number of scattered stations in the northern and southern hemispheres, in an attempt to find how the ozone varies over the surface of the earth.

TWO MILLION VOLT BATTERY.—At the Trafford High Voltage Laboratory of the Westinghouse International Co. there is now in operation a two million volt battery which is used for testing the strings of insulators used for suspending the transmission lines on 220 kilovolt systems. The pressure obtained is not an alternating pressure obtained by transformers, but a unidirectional damped discharge. Instead of using ten groups of condensers as was done last year, twenty are now used. They are charged in parallel by means of large thermionic power tubes and discharged in series. In order to measure the voltage, the spherical electrodes have each to be fifty-nine inches in diameter. The set is of great use in determining the performance of lightning arresters and in the design of cable and transformer insulation to withstand electric surges due to lightning or other causes. The shape of the protective rings round the strings of insulators used on 220 kilovolt systems was determined by experiment, very definite results being obtained. In addition to their electric tests, the strings of insulators are subjected to a mechanical tension of 20,000 lb. A descriptive note of this battery is given in the *Westinghouse International Magazine* for February under the heading of the "World's Most Powerful Lightning Generator."

THE SHAPES OF MOLECULES.—The effective area which a molecule presents to a slow electron depends very markedly on the relative velocity of the two particles, and it has now been shown conclusively that, quite apart from the excitation of quantum transitions, classical kinetic theory cannot account for the nature of the collisions, and fails in particular to explain the apparent transparency of many substances for very slow electrons. In the first number of the new series of the *Annalen der Physik*, E. Brüche has given a review of the results obtained up to the present in this field, including a description of his own recent work upon ammonia and water-vapour. The collected curves showing the molecular area as a function of the speeds of the incident electrons are very instructive, and exhibit regularities which indicate that the details of the collisions are determined both by the atomic constitution of a compound and by the structure of its outer shell of electrons. Perhaps the most remarkable of these is the close correspondence between the curves for methane and for krypton. Dr. Langmuir and Prof. A. O. Rankine had already commented upon this similarity in other connexions, and more recently it has been found that their ionisation potentials are also not much different, being 13 volts for the atom, and 14·6 volts for the molecule. This resemblance to an inert gas evidently indicates that the molecule of methane possesses a high degree of symmetry, and, in the opinion of E. Brüche, affords good evidence for the old model for methane in which the four hydrogen atoms were placed at the angular points of a regular tetrahedron, and the carbon atom at its centre.

FIREDAMP EXPLOSIONS WITHIN CLOSED VESSELS.—The Safety in Mines Research Board has previously studied the effects of firedamp explosions within closed vessels, such as the casings of electrical switchgear, but has now extended this investigation to explosions in vessels divided into intercommunicating compartments (S.M.R.B., Paper No. 49, by C. S. W. Grice and R. V. Wheeler. London: H.M. Stationery Office). Beyling, in Germany, has shown that the ignition of an explosive mixture in one compartment may cause a considerable rise of pressure in another, and this result has been confirmed. An explosion of a mixture of firedamp and air in a comparatively large volume and propagated through a narrow opening into a smaller compartment, may lead to the rapid development of a high pressure, and violent explosions can be caused in this way by even weak mixtures of methane and air. Casings containing inter-connected compartments are therefore unsuitable for use in mines.

PROPERTIES OF BREEZE AND CLINKER AGGREGATES.—Further work that has been carried out on breeze and clinker aggregates is described by F. M. Lea in *Bulletin of the Building Research Station*, No. 5 (London: H.M. Stationery Office). The properties of such aggregates are dependent upon the amount and nature of combustible material present. Unburnt or partially burnt coal in breeze or clinker concrete is a frequent cause of failure, and the presence of only 4 per cent of coal may be responsible for serious damage. The coal causes expansion of the concrete during setting and maturing, and ultimately cracking results. Small quantities of sulphur do not appear to cause appreciable disintegration, although they may increase the rate of corrosion of reinforcement in the concrete. The presence of dust in the aggregate results in a longer period of setting, since more water is required for mixing purposes, but does not cause subsequent unsoundness. The *Bulletin* also describes methods of sampling and testing breeze and clinker aggregates in the field.

THERMAL DECOMPOSITION OF AMMONIA.—Baly and Duncan (1922) claimed that ammonia gas obtained by rapid evaporation of the liquid is less rapidly decomposed by a hot platinum wire than that produced by slow evaporation. This effect was attributed to the existence of two kinds of molecules in equilibrium in liquid ammonia, all the molecules being assumed to pass into the form with the higher energy content on slow evaporation, while on rapid evaporation the equilibrium was supposed to persist in the gaseous state. This work has been repeated by W. A. Stringfellow, who describes his results in the *Journal of the Chemical Society* for January. These results do not confirm those of Baly and Duncan, practically no effect being observed in place of a 25-50 per cent decrease in reactivity with rapidly evaporated ammonia. The addition of water vapour did not produce the great increase in decomposition observed in the earlier work. Stringfellow suggests that as Baly and Duncan apparently did not exhaust their reaction vessel before filling it with ammonia, a rapid inflow of gas would not sweep out the air so completely as a slow stream. The presence of adsorbed gases on the platinum wire might then account for the inhibition of the reaction observed when rapid evaporation took place. The existence of different species of gaseous ammonia appears to be very unlikely.

Cruise of the *Carnegie*.

THE non-magnetic yacht *Carnegie*, which left Washington last May for a three-year magnetic and electric survey of the oceans, has now completed the first unit of her voyage—that of encircling the North Atlantic. In three letters to the Carnegie Institution of Washington (published by the Press Service Bureau), Captain Ault, who is in command both of the ship and of the Expedition, describes the progress of the work so far accomplished. The first place was Plymouth, reached only after encountering severe storms, then Hamburg, Iceland, Greenland, Newfoundland and Barbadoes. Oct. 9 was the date planned for arrival at Panama, and as these letters were being finished the ship was about 140 miles from that place, and the date was Oct. 9, thus keeping well to the schedule.

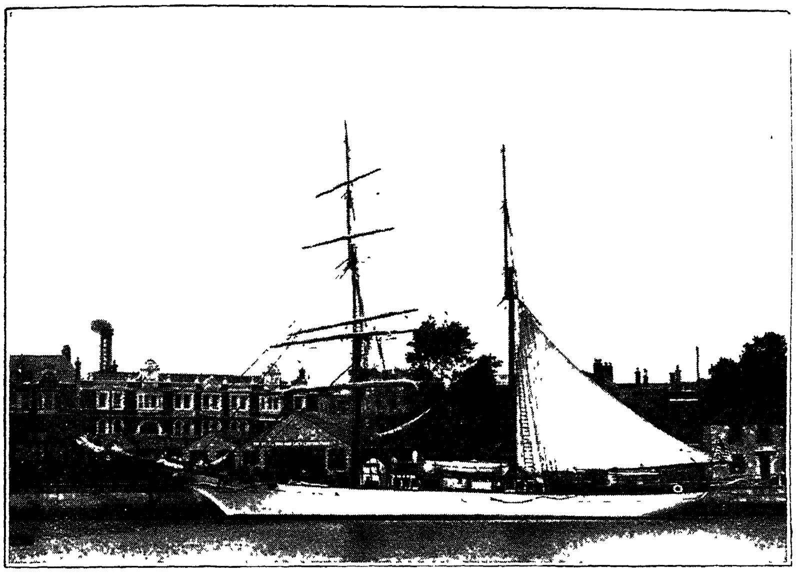

FIG. 1.—The *Carnegie* at Plymouth

The work is in full swing. In this cruise a large amount of additional research in physical oceanography and biology is undertaken. Every other day a magnetic station is occupied for compass declination, inclination, and horizontal intensity. On alternate days an ocean station is occupied for water samples (salinity, hydrogen ion concentration, phosphate content, oxygen content) and temperature, with, occasionally, bottom samples and tow-nets.

The magnetic declination or compass variation at 135 stations has been determined, and the inclination and horizontal force at 49 stations, mostly near stations of former cruises. Atmospheric electric observations have been made daily and many photographic records of continuous daily changes in the electric potential gradient: also eight 24-hour series of observations of conductivity, ionic content, and penetrating radiation. Three hundred and thirty determinations of the depths of the sea have been made with the sonic depth-finder. This electrical apparatus for measuring the depth of the ocean floors records the time required for sound waves, from an oscillator mounted on the hull below the water line, to reach bottom and be reflected back to the surface. Checks with the wire soundings show that the accuracy of the depth-finder is within expected limits.

For biological studies, tow-nets at surface, 50 m. and 100 m. depth are taken, and the new Pettersson plankton pump, after several improvements, has been included as a regular instrument at each ocean station. This is so arranged that it can be worked at a given depth by the release of a 'messenger,' the power being supplied by a 30-pound weight on the end of 100 m. of wire wound on a reel on the pump. 150 litres of water is strained through a small silk net attached to the pump. When all the wire has run out the pump is closed off and hauled to the surface. Salinities are now determined by means of the salinity bridge by the evening of the day on which the samples are taken. Continuous records of both wet-bulb and dry-bulb temperatures or change of humidity at three positions have been secured. The 'boom walk,' as used by Beebe (two 30-foot booms with net between extending from the ship's side), enables the naturalist to walk out over the water and use the dip-net and tow-nets outside the disturbances caused by the wash of the ship.

On Aug. 7 a station was occupied at the edge of the Grand Banks of Newfoundland in the cold Labrador Stream, which at that point had a depth of 130 m. At the surface the temperature was 52° F., but at a depth of only 170 feet the thermometer fell to 34°. Three days later in the Gulf Stream the water surface temperature was 79° F.

Those who have seen the stores of spare apparatus on board have possibly marvelled at their numbers; careful provision fully justified when one realises the risk of loss every time an instrument is used. One such instance is recorded by Dr. Ault, when a bottom sampler, eleven Nansen water-bottles, and twenty-two deep-sea reversing thermometers were lost by the breaking of a wire about $2\frac{1}{2}$ miles down.

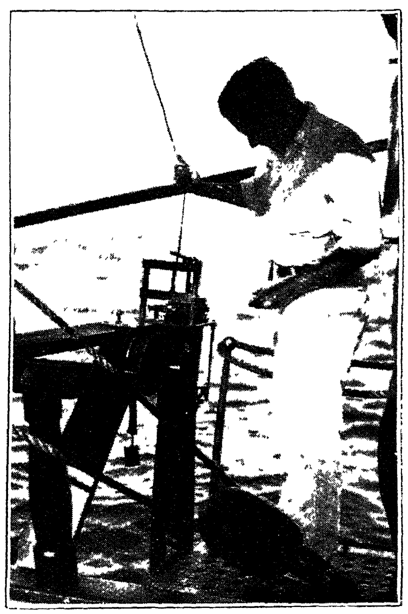

FIG 2—Working the Pettersson plankton pump.

The *Carnegie* is happy in having contact by radio with America, England, France, Holland, and Germany.

The Expansion of Telephone and Supply Systems.

THE problems that arise in connexion with the expansion of telephone systems are in some respects analogous to the corresponding problems in the supply of electric lighting. The Institution of Electrical Engineers therefore arranged on Jan. 10 that papers on each of these subjects should be read at the same meeting so that the solutions adopted by the telephone engineers might be compared with those adopted by the supply engineers. The title given to each paper was "The Anticipation of Demand, and the Economic Selection, Provision, and Lay-out of Plant."

Mr. J. G. Hines discussed the telephone system and Capt. Donaldson the electric power system. The first problem that has to be solved in both systems is the forecasting of the probable number and distribution of subscribers that will exist in a given area at a given time. Once this is settled, the provision of a lay-out which will ensure an efficient service at a minimum cost over this period is a technical problem which should admit of a rigorous mathematical solution.

Secondary problems arise, however. In connexion with telephony there is the 'busy hour,' and in connexion with electric supply there is the 'peak load.' In trunk line telephony the difficulty is sometimes met by having a special tariff so as to induce subscribers to communicate at the less busy hours, and occasionally, in electric supply, by means of meters which register more rapidly at stated times. There are many points of dissimilarity between the two problems. When a house has been wired for the electric light, it is most probable that there will be always a user in that house. In the case of telephone supply, especially in private dwellings, a change of occupier usually results in the telephone circuit serving the premises being given up. This involves recovery of the apparatus and the temporary or permanent abandonment of all the internal wiring, which is always provided by the Post Office.

In large cities high-class property is often found next door to poor dwellings. Before the period covered by the Post Office forecast has expired, the smaller properties may be pulled down and replaced by blocks of flats or business premises, each requiring many telephones. It is necessary, therefore, to make detailed inquiries about possible alterations to property. Certain businesses like stockbroking and bookmaking are very fluctuating. When there is a rush of work the number of telephones may be increased five times, and then when the depression comes they are given up.

The data given show why overhead transmission is desired by engineers. A wire made of cadmium copper and weighing 40 lb. per mile used overhead has a speech transmission efficiency equal to that of a 200 lb. per mile underground cable. Public authorities, however, are increasingly reluctant to give permission to erect poles in public footways. Capt. Donaldson said that the telephone problem is the more difficult, because each consumer must have his own individual pair of wires at least so far as the first telephone exchange.

If the electric lighting stations built twenty-five years ago had been ten times larger, it would have been in the country's interest. The replacement of reciprocating engines by the turbine has made it possible to accommodate considerably larger units of supply in the original engine rooms, but in many cases considerable alterations have had to be made. Capt. Donaldson pointed out the fallacy of always replacing an engine by one of double the size; it is always necessary to assume that one engine may be out of commission. Hence the maximum reserve of power is obtained when all the engines are of equal size. The general situation is rapidly passing out of the hands of the smaller undertakers. Power engineers by careful study of the yearly loads can make reasonably accurate forecasts of the demand for some years in advance.

The Rubber Research Institute of Malaya.

THE first issue of the *Quarterly Journal of the Rubber Research Institute of Malaya*, Kuala Lumpur, January 1929, bears witness to the very active steps that have been taken to put the new Research Institute into working order. The director, Dr. G. Bryce, arrived in Malaya to take up his duties in September 1926. Some local appointments were made during the autumn of that year, and the other officers of the station were gradually brought in during 1927 and 1928, the seventeenth appointment being made in November 1928. By June 1927 the heads of the chemical, pathological, botanical, and soils divisions of the Institute were appointed, and engaged in visiting the neighbouring rubber research stations in Sumatra and Java. Temporary laboratory accommodation was provided by adapting a bungalow, and four months after the arrival of the heads of divisions in Malaya they had presented programmes of work for their respective divisions for the consideration of the Board of Control.

In this first issue of the *Quarterly Journal*, brief summaries of the work of the different divisions are given, for the period up to Sept. 30, 1928. These show that the officers appointed have lost no time in grappling with the many-sided problems presented by the commercial cultivation of the rubber plant, and the preparation of the latex for market.

The bulk of the journal consists of articles by various officers of the Institute upon many of the interesting problems that arise in connexion with research upon the growing and preparation of rubber. Besides being of interest to the rubber planters, many of these articles have special interest to botanists, colloid chemists, and other investigators of agricultural and industrial problems, who are not directly concerned with the rubber industry. Occasionally, however, a certain obscurity of expression makes some of these articles difficult to follow, and particularly if the Research Institute wishes to carry interested growers with it in its investigations through the medium of its journal, it would seem worth while to expend more time and trouble upon the form in which these investigations, often themselves of great intrinsic interest, are described in print.

Dr. Haines discusses a topic of very general interest in countries with a tropical rainfall when he reviews the pros and cons of methods of silt pitting as a means of defence against excessive soil erosion. Experience which this investigator obtained in the classic experimental fields of Rothamsted is here utilised to visualise a soil problem specially characteristic of tropical and sub-tropical conditions. The botanical division reports much active work upon vegetative propagation. Mr. Mann, fresh from his contact with methods of

fruit culture at the Experimental Station at Long Ashton, near Bristol, discusses the conditions governing successful bud unions in Malaya, where vigorous growth of shoot and scion at the time of union, together with fair humidity in the weeks following the budding operation, seem the most essential conditions for success.

Messrs. A. R. Sanderson and H. Sutcliffe give an account of some very valuable selection work on rubber they have had in progress before the formation of the Institute. These experiments confirm the general impression that the selection of high yielding stock on any other basis than the yield of dry rubber over a long period of tapping, can, as yet, only be made with considerable uncertainty.

The creation and propagation of high yielding strains —which Dr. Weir, the head of the pathological division, reminds the reader may be at any time required endowed with resistance to some newly introduced pathogen, such as the South American leaf blight, which Dr. Weir has studied in its native habitat—can obviously not be neglected by the Rubber Research Institute. Mr. Morris states that during a season's observations no pollen-carrying insect has been seen to visit the female flowers of *Hevea*, which, it must be remembered, is not of Malayan origin, but an introduced plant isolated from its normal insect visitors. Artificial pollination is successful between various selected clones, and a few seedlings have thus been obtained for further trial, but self-pollination within the clone is usually negative in result. The further analysis of the conditions, both internal and external, that contribute to successful pollination and fertilisation, is a promising field of investigation.

Many other points of detail as to the chemical properties of the rubber, its preparation and various commercial defects, diseases of cover crops, of young, budded plants, etc., are dealt with in this first number of the new journal. There is no doubt that if this standard is maintained, the *Quarterly Journal* of the new Rubber Research Institute will be a publication of permanent scientific value.

Association of Technical Institutions.

THE annual general meeting of the Association of Technical Institutions was held in the Grocers' Hall, London, on Feb. 22 and 23. As is customary, the installation of the president took place at the opening session, and, distinguished as have been the occupiers of the presidential chair in the past, the new president, Sir J. E. Kynaston Studd, is one of whom the Association may be justly proud. By a happy chance, the year of his presidency coincides with his year of office as Lord Mayor of London. But it is not only the civic honours that are his which distinguish him in and qualify him for his new office. For some years now his activities in connexion with the Regent Street Polytechnic, of which he is president, have been well known.

Since he was therefore in a position to speak to the Association as an expert, Sir Kynaston Studd's presidential address was expected to be one of unusual authority. Nor was his audience disappointed. His review of the work of such recent committees as the Balfour Committee on Trade, the Malcolm Committee on Education and Industry, and the Emmott inquiry into technical education and industry, was broad and illuminating. The conclusion he drew from the reports of these committees may be summarised by saying that, although the Board of Education is now in a position as a result of the work done to do much to help technical education to attain the greater place it merits in our system, a great deal of the task of getting industry to come more and more to the technical college for informed help must be borne by such associations as the A.T.I. In connexion with all this, he did not attempt to minimise the work done by the Atholl Committee on Examinations, but it was clear that he was closely in touch with the views of the majority of those engaged in technical education when he suggested that examinations are the least important part of the work of technical education. We were glad, too, to note that he pressed home a vital point to which attention has already been directed in these columns (see NATURE, Nov. 12, 1927, p. 681; and July 28, 1928, p. 121)—the status of the craftsman must be equal to that of any other worker; an end which will be difficult to attain unless industry is prepared to guarantee the same conditions of permanency to craftsmen as it does to clerks and others of the administrative staffs.

Papers read and discussed during the meetings included "Broadcasting and its Relation to Further Education," by Mr. C. A. Siepmann, of the B.B.C.; "Industrial Safety," by Sir Gerald Bellhouse, H.M. Chief Inspector of Factories; and "Technical Training for Women," by Miss E. E. Cox, of the L.C.C. Barrett Street Trade School.

In connexion with the paper on industrial safety, a visit was arranged to the Home Office Industrial Museum, where safety devices are set out in admirable fashion. Few people, as Sir Gerald Bellhouse pointed out in his paper, realise how big a toll accidents make upon industry. Yet the most recent figures show that 156,974 accidents (of which 973 were fatal) were reported during 1927 to the Factory Department. Out of these cases, those which come within the Factory and Workshop Acts mean that each year about £2,500,000 is paid in compensation: additional administrative, legal and medical costs must bring the figure to not less than £5,000,000 per annum. Statistics such as these should in themselves be sufficient to make employers, employees, staffs, and students of engineering schools in universities and technical colleges desire to visit the Home Office Industrial Museum, where may be seen all the best methods of preventing danger to life and limb which have become incidental to industrial processes.

University and Educational Intelligence.

CAMBRIDGE.—Mr. E. N. Willmer has been appointed University lecturer in physiology.

The following grants have been made from the Balfour Fund: £100 to Dr. C. M. Yonge, for researches at Honolulu and elsewhere in reference to his experiments on the Great Barrier Reef; £50 to Mr. F. S. Russell, for researches on the plankton of the Great Barrier Reef region.

Birbai Sahni, Emmanuel College, has been approved for the degree of doctor of science.

LEEDS.—Mr. F. J. Dent has been appointed gas research chemist in the Department of Coal Gas and Fuel Industries in succession to Dr. A. Parker, who has resigned in order to take up a responsible post with the Water Pollution Section of the Department of Scientific and Industrial Research. Mr. Dent has been working in the Department under Prof. J. W. Cobb for the past two years upon the gasification of special cokes in oxygen, and upon heat treatment in hydrocarbon and other gases as a factor influencing the reactivity of coke.

London.—An offer by the trustees of the late Mr. C. H. Clark of a sum of £10,000 for the establishment of a lectureship in the history and progress of preventive medicine and tropical hygiene has been accepted. The Prime Minister has forwarded a grant of £1000 from the Beaverbrook Fund for Medical Research, to be applied to the purposes of, and administered under, the scheme for the Thomas Smythe Hughes Medical Research Fund.

Dr. T. G. Hill, reader in plant physiology at University College, has been appointed to the University chair of plant physiology, tenable at University College, as from Aug. 1 next. He is the author (with Dr. P. Haas) of "An Introduction to the Chemistry of Plant Products" (1913), and of numerous papers on the structure and development of the higher plants, oxidative processes, etc., in botanical and other journals.

Dr. E. J. Salisbury, reader in plant ecology, has been appointed to the Quain chair of botany, tenable at University College, as from Aug. 1 next. His recent publications include papers on the influence of earthworms on soil reaction, geographical distribution of plants, and the causes and ecological significance of stomatal frequency.

Prof. W. E. Le Gros Clark, professor of anatomy at St. Bartholomew's Hospital Medical College, has been appointed as from Sept. 1 next to the University chair of anatomy tenable at St. Thomas's Hospital Medical School.

Sir John Dewrance, Prof. W. T. Gordon, Dame Helen Gwynne-Vaughan, and Sir John Snell are among the recently appointed fellows of King's College.

Oxford.—All Oxford men who have worked in the University Museum will be gratified that the degree of M.A. *honoris causa* has been conferred on Alfred Robinson, assistant to the secretary to the curators, and a well-known figure to all science students in Oxford for the last fifty years.

At a forthcoming meeting of Congregation, decrees will be proposed expressing the gratitude of the University (1) for the gift, received through the Prime Minister, of £1000 from Lord Beaverbrook for the furtherance of medical knowledge, and (2) for the bequest by the late Prof. A. W. Scott of £4322 to be applied for the furtherance of physical science.

Sheffield.—Applications are invited for an Ironmongers' Company Research fellowship, value £500, and for two Ironmongers' Company Research Scholarships, each of the value of £150, particulars of which can be obtained from the Registrar, The University, Sheffield. The latest date for the receipt of applications is April 1.

Wales.—Applications are invited from graduates of the University of Wales for five fellowships, each of the annual value of £200 and tenable for two years. The applications must be received not later than June 1, by the Registrar, University Registry, Cathays Park, Cardiff.

The New York correspondent of the *Times* has announced three important gifts for education in the United States. North-Western University is to receive about £1,600,000 under the will of Mr. Milton H. Wilson; New York University has received an unrestricted endowment of £200,000 from Mr. and Mrs. Percy S. Straus; and Newhaven Hospital, which is affiliated to the Yale School of Medicine, has received £400,000 from the General Education Board of New York City, to be devoted to a new laboratory and dispensary and a service unit.

Calendar of Patent Records.

March 4, 1633.—On Mar. 4, 1633, Richard Delamain petitioned Charles I. that, in accordance with a promise given by the king two years earlier, he might have the sole making of a "mathematical instrument extracted from the logarithms and projected in circles for the speedy operating of mathematical practices." The petition passed the Signet Office on the same day, but no patent is enrolled, and it is uncertain whether this first patent for a slide rule was ever actually issued. Delamain was not the first inventor of the slide rule. The credit for this belongs to William Oughtred, who, according to his friend and translator, William Forster, had invented the instrument some years before and had not published the invention because "it is a preposterous course of vulgar teachers to begin with instruments, and so instead of artists to make their scholars only doers of tricks and as it were juglers; to the despite of art, losse of precious time, and betraying of willing and industrious wits unto ignorance and idleness."

March 5, 1825.—On this date there was granted to W. H. James, one of the pioneers of railway transportation, a patent for a system of train propulsion in which all the axles throughout the train were driving axles, longitudinal shafts on the carriages operating the wheels through bevel gearing and being connected to each other by universal couplings, the front shaft being driven by a steam engine or other agent. An experimental line was laid down on which inclines of 1 in 12 were successfully negotiated, but the system was never adopted on the railways of Great Britain.

March 6, 1648.—During the last few years of Charles I. the ordinary machinery of granting patents broke down, and there are no entries in the printed indexes for the period 1642–49. The patent granted to Sir William Petty on Mar. 6, 1848, for his invention of double and multiple writing, was issued by the authority of an ordinance of the "Lords and Commons assembled in Parliament," which formed the warrant to the Solicitor-General and to the Commissioners of the Great Seal. Petty seems to have had some difficulty in securing the adoption of the invention, for in the following year Parliament is petitioned by one Henry Morris to grant Petty and Morris "either a tax of 2*d.* a ream on paper, or 2*s.* 2*d.* on 60 skins of parchment for a few years, or else £1500 or £2000 down for their services, or some good office."

March 6, 1916.—Rustless steel first attracted public attention when stainless table-cutlery was introduced in 1914, though the importance of chrome and of nickel alloys had long been recognised. The remarkable properties of high chromium iron were, however, not fully realised until the researches of Harry Brearley of Sheffield, which resulted in the production of a steel containing between 9 and 16 per cent chromium and not more than 0·7 per cent carbon, which was practically untarnishable and could be forged, rolled, hardened, and tempered, under commercial conditions. Brearley's discovery was published before a British patent was applied for, but he obtained patents in Canada and the United States, the application in the latter country being filed on Mar. 6, 1916.

March 8, 1859.—A satisfactory cotton-harvesting machine has yet to be discovered, and most of the world's cotton is still picked by hand, but of the many attempts to solve the problem, the pneumatic picker has had the greatest amount of success. The first patent for a pneumatic harvester was granted in the United States to John Griffin on Mar. 8, 1859, steam being employed to produce the vacuum.

Societies and Academies.

LONDON.

Royal Society, Feb. 21.—**P. Kapitza**: The change in electrical conductivity in strong electric fields (Parts 1 and 2). The change of resistance in a transverse field at temperatures of room, of solid carbon dioxide and ether, and of liquid nitrogen, has been studied in many metals. It follows the same law in all of them. The formula obtained gives a square law in weak fields and a linear law in stronger fields. Change of resistance follows a linear law with increasing field, but in weak fields it is masked by disturbances existing in the metal equivalent to an internal magnetic field. This additional resistance is independent of temperature, while the ideal resistance has a constant value for a given temperature for each metal, independent of its physical and chemical state. The additional resistance is identical with the residual resistance which is observed at very low temperatures. Supraconductivity is a general phenomenon in all metals, but is masked by additional resistance, which disappears at very low temperature in certain metals.—**R. R. Nimmo** and **N. Feather**: An investigation of the ranges of the long-range α-particles from thorium C and radium C, using an expansion chamber. 'Extrapolated' ranges 9·90 and 11·70 cm. in standard air were obtained for the long-range α-particles from thorium C in the ratio of 1 : 5·1. 541 particles have been observed belonging to these groups. In addition, 9 had ranges between 12·5 cm. and 17 cm., and 13 had longer ranges. The range of the most abundant group of long-range α-particles from radium C was measured as 9·16 cm.; it is likely that there are others with ranges 8·1 cm., 10·0 cm., and 11·0 cm. respectively. Nearly 500 long-range particles from radium C were recorded.—**C. R. Burch**: Some experiments on vacuum distillation. The method of evaporative distillation can be applied to the derivatives of petroleum. An elementary kind of fractionation is possible. Petroleum derivatives of exceedingly low vapour pressure can be prepared.—**E. C. C. Baly** and **N. R. Hood**: The photosynthesis of naturally occurring compounds (4).—**B. W. Currie** and **R. Alty**: Adsorption at a water surface (1).—**W. G. Palmer**: Some adsorption isothermals for a plane platinum surface.—**B. Lambert** and **A. M. Clark**: Studies in gas-solid equilibria.—**G. C. Laurence**: Relative velocities of the alpha-particles emitted by certain radioactive elements.—**H. W. Thomson** and **C. N. Hinshelwood**: The mechanism of the homogeneous combination of hydrogen and oxygen.—**E. G. Dymond** and **E. E. Watson**: Electron-scattering in helium.—**E. T. Hanson**: Diffraction and resonance.—**S. Goldstein**: (*a*) The forces on a solid body moving through viscous fluid. (*b*) The steady flow of viscous fluid past a fixed spherical obstacle at small Reynolds' numbers. Oseen's equations for the flow of a viscous fluid at small Reynolds' numbers past a fixed spherical obstacle are solved completely, and a table given of the resulting values of the drag coefficient.—**J. Taylor**: On the chemical interaction of ions, and the 'clean-up' of gases at glass surfaces under the influence of the electrical discharge.—**H. M. Macdonald**: The total reflection of electric waves at the interface between two media.—**L. Hartshorn** and **D. A. Oliver**: On the measurements of the dielectric constants of liquids, with a determination of the dielectric constant of benzene. An accuracy of 1 in 10,000 is obtained, using a capacity method. The method requires a comparatively large volume of liquid. For very pure liquids in small quantities, a comparison method is used. The dielectric constant of benzene is 2·2825 at 20° C., with a probable error of ± 2 parts in 10,000, mainly due to difficulties of obtaining a sample absolutely free from water.—**J. W. Fisher**: The wave equation in five dimensions.—**E. Griffiths** and **J. H. Awbery**: Measurements of flame temperatures.—**K. Lonsdale**: The structure of the benzene ring in $C_6(CH_3)_6$. The benzene ring in this compound is similar in shape and size to the six-carbon ring in graphite, the nuclear carbons having a diameter of 1·42 A. Three of the valencies of aromatic carbon are co-planar, the ring itself and all the side chain carbon atoms lying in the (001) cleavage plane. The puckered or 'diamond' type of benzene ring, and Morse's model are inadmissible.

Geological Society, Feb. 6.—**E. St. J. Burton**: The horizons of Bryozoa (Polyzoa) in the Upper Eocene beds of Hampshire. Special horizons on which an abundance or deficiency of bryozoan remains occur are indicated within the three divisions of the Barton Beds (Lower, Middle, and Upper Barton). A recurrent facies of sedimentation may be coincident with the reappearance of species on higher horizons in the series.—**M. Black**: The upper estuarine series of Yorkshire. The Estuarine Series of Yorkshire is of deltaic rather than estuarine origin, and bears a close resemblance to the Coal Measures. The Upper Estuarine Series is best exposed in the coast-section between Gristhorpe and Cloughton (Yorkshire), where the sequence can be made out. It is possible to distinguish between autochthonous plant-beds and allochthonous, or drifted, ones. The former are rare in the Upper Estuarine Series. The drifted plant-beds are much better developed. Among these, a definite relationship exists between the type of sediment and the flora which it encloses. The plant-fragments seem to have behaved as a sediment transported by the water of the distributaries.

Society of Public Analysts, Feb. 6.—**T. P. Hilditch** and **Eveline E. Jones**: The fatty acids and component glycerides of some New Zealand butters. The procedure consisted in oxidising the butter fat by means of permanganate under conditions in which all unsaturated components were transformed into acidic products, whilst glycerides containing only saturated fatty acids remained unaltered. These fatty acids were recovered and their composition determined.—**A. Scott Dodd**: A new test for boric acid and borates. The pink coloration produced by adding mannitol and methyl red or sofnol indicator No. 1 to a neutral solution is characteristic of boric acid, a distinct reaction being obtained with so little as 0·2 mgm. The only substances causing any interference with the distinctness of the reaction are phosphates, arsenates, chromates, and tungstates, which make it difficult to ascertain the exact point of neutrality.—**B. E. Dixon**: The determination of small quantities of beryllium in rocks. The chief obstacle to the accurate determination of small quantities of beryllium in silicate rocks is the difficulty of separating it from titanium. This difficulty has been overcome by the use of *p*-chloroaniline, which will precipitate titanium completely.

DUBLIN.

Royal Dublin Society, Jan. 22.—**W. R. G. Atkins** and **H. H. Poole**: The photoelectric measurement of the illumination in buildings. The vertical illumination was measured simultaneously in an exposed position and in the building. The percentage ratio when the sun is obscured is called the 'daylight factor.' A dwelling-house and an old church were examined. The illumination in the former was less than 1 per cent

in most places, rising to 7 per cent just inside large windows, or 14 per cent with the photometer sloped towards the light. The factor in the church varied from 0·02 to 0·86 per cent, or, with sloped photometer, from 0·03 to 1·85 per cent. It seems to be futile to use special glass, transparent to ultra-violet light, in the usual type of dwelling-house in windows which do not, at some time of the day, receive direct sunlight.—**H. H. Poole**: A modified form of radium emanation apparatus. The apparatus in use in the Irish Radium Institute for pumping off emanation and drawing it into capillary tubes for therapeutic purposes has been modified so as to render its action more automatic, thus reducing the exposure of the operator to the radiations, and enabling the work to be carried on by a succession of less highly skilled workers than were required with the apparatus in its old form.

Royal Irish Academy, Jan. 28.—**P. J. Nolan** and **C. O'Brolchain**: Recombination of ions in atmospheric air (Part 1). Investigation of the decay coefficient by Schweidler's method. The linear recombination law for small ions in atmospheric air is verified. The recombination coefficient between small ions and nuclei is not constant. The variation does not appear to be connected with the concentration of dust particles in the air.—**P. J. Nolan**: Recombination of ions in atmospheric air (Part 2). The law of recombination of ions and nuclei. The relation between the rate of production of ions in atmospheric air and the equilibrium concentrations of small ions and nuclei is best represented by the equation $q = an^2 + \zeta n\sqrt{N}$ where $\zeta = 55 \times 10^{-5}$. The results of field observations generally support the proposed equation.

EDINBURGH.

Royal Society, Feb. 4.—**N. B. Eales**: The anatomy of a fœtal African elephant, *Elephas africanus* (*Loxodonta africana*) (Part 3). The contents of the thorax and abdomen, and the skeleton. A detailed specification of the Proboscidea is given, anatomical differences between *Elephas* and *Loxodonta* are noted, and the relationships between the Proboscidea and other orders of mammals are discussed. The group has numerous features of a primitive nature, in which it exhibits resemblances with the Rodentia, Sirenia, Hyracoidea and the Primates. The nearest relatives were the ancestors of the modern Sirenians.—**A. D. B. Smith** and **J. R. Brown**: Rôle of inbreeding in the development of the Jersey breed of cattle. Inbreeding has played a small part in the construction of the breed in England. Sewall Wright's coefficient now stands at only 3·9 + 0·3 as compared to the Clydesdale breed of horses with 6 and Shorthorn cattle with 26. Cows with annual lactations of more than 1000 gallons in less than a year are significantly less inbred, having a coefficient of only 1·85. Possible reasons are: (1) miscellaneous inbreeding does not produce good results in yield; (2) heterosis between two strains; (3) inheritance of milk yield may not be in a common autosomal manner, but may be sex linked, in which case only certain types of inbreeding would be effective.—**A. W. Greenwood** and **J. S. S. Blyth**: An experimental analysis of the plumage of the brown Leghorn fowl. Whereas the plumage typical of the male is developed independently of the gonad and depends for its maintenance on a certain level of thyroid functioning, both gonad and thyroid play a part in regard to that of the female: the former stimulates the latter to a higher level of activity than that present in the male and so indirectly causes a hyperthyroid effect on the feathers. At the same time it modifies this condition by acting directly on the feathers and restricting the deposition of melanin into pencillings.—**C. W. Stump**: A human blastocyst *in situ*. The blastocyst was obtained from the body of a woman aged forty-six years. It was fixed the day after the death of the mother, who was killed by a motor-car accident, but was slightly injured. Examination of the sections of the blastocyst and of the reconstructions made from the sections, place it in Bryce's group *D* of human blastocysts, which, now, with the addition of this new specimen, named H 381, and Stieve's Hugo specimen, includes thirteen blastocysts of relatively similar age.

GENEVA.

Society of Physics and Natural History, Dec. 6.—**Rolin Wavre**: The formula of Clairaut relative to geodesy. The author obtains Clairaut's formula by a method much simpler than those hitherto given. His calculation has the double advantage of not requiring the use of spherical functions and of making an approximation only at the last stage of the new and rigorous formulæ.—**Pierre Dive**: Internal movements of the terrestrial fluid. The author applies the formulæ recently established by him, on the laws of rotation of a heterogeneous fluid with a density increasing with the depth, to the case of the earth. Geophysicists admit that the continents should be considered as a light scoria floating on a denser viscous mass. The calculations of M. Dive give increases of velocity at a depth of 100 kilometres of 5·3, 7, 8·6, 9·5 cm. per second for surface densities of 3, 2·6, 2·5, 2·4 respectively. Of two continental masses floating in the viscous underlayer, the larger and more deeply submerged will be carried towards the east with a greater velocity. This movement is certainly much reduced by the viscosity, not taken into account in the calculations. This calculation gives a concrete and simple explanation of the tangential force which geologists have long considered as the principal factor in the deformations of the solid part of the globe.—**Adrien Jayet**: The age of the lower portion of the sub-lithographic limestones of the calcareous Alps of Haute Savoie. The lower part of these limestones, styled Senonian in the explanation of the geological map of France (1/80,000), merge laterally into fossil-bearing Cenomanian layers. Hence there is not, at the point where the latter are missing in the series, an interruption in the series. It is a matter of a lateral change of facies in a continuous sedimentary series.

VIENNA.

Academy of Sciences, Nov. 16.—**J. E. Hibsch**: The geological age of the sands and sandstones of the Bohemian Mittelgebirge, hitherto held to be Middle Oligocene.—**K. Menge**: (1) A theorem on the length of an arc.—(2) The general separation theorem.

Nov. 22.—**W. J. Müller** and **O. Löwy**: The theory of passivity phenomena. (4) The dependence of the specific time of passivation for iron on the concentration and nature of the electrolyte.—**R. Dworzak** and **T. Lasch**: Cyclo-acetals.—**F. Heritsch**: *Michelinia Abichi* from the upper carboniferous of Nassfeld in the Carnic Alps.—**D. Poerner-Patzelt** and **A. Pischinger**: The behaviour of the structures of striated muscle fibres towards acids. Muscles of various sorts were used in acetate–acetic acid buffers and with known hydrogen ion content and afterwards examined microscopically.—**K. Przibram**: A colour change by pressure (piezochromy) in fluorite. Green fluorite powdered and then compressed at 10,000 kgm. per sq. cm. becomes violet.—**L. Kober**: Mesozoic breccias in the upper schist cap of the Sonnblick and Glockner group.

Official Publications Received.

BRITISH.

Canada. Department of Mines: Mines Branch. Diatomite: its Occurrence, Preparation and Uses. By V. L. Eardley-Wilmot. (No. 691.) Pp. viii+182. (Ottawa: F. A. Acland.) 30 cents.

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 67, No. 385, January. Pp. 125-216+xxxvi. (London: E. and F. N. Spon, Ltd.) 10s. 6d.

The British Electrical and Allied Industries Research Association (Incorporated). Eighth Annual Report, October 1, 1927, to September 30, 1928. Pp. 71. (London.)

The Scientific Proceedings of the Royal Dublin Society. Vol. 19 (N.S.), No. 14: On the Structure of *Palaeacis*. By Dr. Louis B. Smyth. Pp. 125-138+plates 6-8. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 2s.

The Proceedings of the Physical Society. Vol. 41, Part 1, No. 226, December 15, 1928. Pp. viii+112. (London.) 7s. net.

City and County of Bristol: The Bristol Museum and Art Gallery. Report of the Museum and Art Gallery Committee for the Year ending 30th September 1928. Pp. 24+12 plates. (Bristol.)

Western Australia. Annual Progress Report of the Geological Survey for the Year 1927. Pp. 39+11 plates. (Perth: Fred. Wm. Simpson.)

The Why and Wherefore of Farming: a Course for Elementary Schools in Rural Economy. By Dr. B. A. Keen. Course 1: Broadcast from London and Daventry, Fridays, September 21st–December 14th (omitting October 26th), 2.30-2.55 p.m. Pp. 32. 1d. Course 2: Broadcast from London and Daventry, Fridays, January 18th–March 15th, 2.30-2.55 p.m. Pp. 36. 1d. (London: British Broadcasting Corporation.)

Proceedings of the Royal Society of Edinburgh, Session 1927-1928. Vol. 48, Part 3, No 16: The Lattice Points of a Circle. By Prof. J. R. Wilton. Pp 191-200. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 1s.

Department of Scientific and Industrial Research. Report for the Year 1927-28. (Cmd. 3258.) Pp. v+217. (London: H.M. Stationery Office.) 4s. net.

Biological Reviews and Biological Proceedings of the Cambridge Philosophical Society. Edited by H. Munro Fox. Vol. 4, No. 1, January. Pp. 102+7 plates. (Cambridge: At the University Press.) 12s. 6d. net.

Proceedings of the Geologists' Association. Edited by A. K. Wells. Vol. 39, Part 4, January 21st. Pp. 369-503+viii. (London: Edward Stanford, Ltd.) 5s.

Rubber Research Institute of Malaya. Quarterly Journal, Vol. 1, Nos. 1 and 2, January. Pp. 120. (Kuala Lumpur.) 1 dollar.

Journal of the Indian Institute of Science. Vol. 11A, Part 14: Oil from the Seeds of *Adenanthera pavonina*—A Source of Lignoceric Acid. By S. M. Mudbidri, P. Ramaswami Ayyar and H. E. Watson. Pp. 173-180. (Bangalore.) 8 annas.

Southern Rhodesia: Geological Survey. Bulletin No. 11: The Geology of the Country around the Lonely Mine, Bubi District. By A. M. Macgregor. Pp. 96+7 plates. Short Report No. 23: Interim Report on the Geology of the Chromite Deposits of the Umvukove Range, Lomagundi District. By F. E. Keep. Pp. 10+3 plates. (Salisbury, S. Rhodesia.)

FOREIGN.

Bulletin of the Bingham Oceanographic Collection, Peabody Museum of Natural History, Yale University. Scientific Results of the First Oceanographic Expedition of the *Pawnee*, 1926. Vol. 2, Art. 5: Mollusks from the Gulf of California and the Perlas Islands. By Lee Boone. Pp. 17+3 plates. Vol. 2, Art. 6: Echinoderms from the Gulf of California and the Perlas Islands. By Lee Boone Pp. 14+9 plates. Scientific Results of the Third Oceanographic Expedition of the *Pawnee*, 1927. Vol. 3, Art. 3: Deepsea Fishes of the Order Iniomi from the Waters around the Bahama and Bermuda Islands; with Annotated Keys to the Sudidae, Myctophidae, Scopelarchidae, Evermannellidae, Omosudidae, Cetominidae and Rondeletidae of the World. By Albert Eide Parr. Pp. 193. (New Haven, Conn.)

Koninklijk Nederlandsch Meteorologisch Instituut. No. 106a: Ergebnisse aerologischer Beobachtungen. 15, 1926. Pp. iv+46. 2.50 fl. No. 104a, Supplement: Oceanographische en meteorologische Waarnemingen in den Indischen Oceaan, December, Januari, Februari (1856-1910). Tabellen, Waarnemingen Noord van O°, (1856-1923). Pp. iv+36. 1.25 fl. No. 108. Seismische Registrierungen in De Bilt. 13, 1925. Pp. ix+52. 1.00 fl. (Utrecht: Kemink en Zoon.)

Journal of the Faculty of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 23, Part 2: Chemical Studies on the Brewing Barley. By Yukihiko Nakamura. Pp. 29-86. (Tokyo: Maruzen Co. Ltd.)

Scientific Papers of the Institute of Physical and Chemical Research. Nos. 168-169. On the Mode of Areal Distribution of Gliding Sparks on a Surface coated with Granular Conductor, by Ukitirô Nakaya; On the Mechanism of Gliding Spark, by Torahiko Terada. Pp. 237-264+plate 8. 40 sen. No. 170: Physico-chemical Studies on Bioluminescence. 6: The Mechanism of Luminescence in the Cypridina Luciferin and Luceferase Suggested. By Sakyo Kanda. Pp. 265-269. 15 sen. Supplement, Vol. 9, No. 7: A Trial to remove Hydrogen from Higher Fatty Acids. By Tsuneo Suzuki and Torao Kurita. Pp. 5-6. 10 sen. (Tokyo: Iwanami Shoten.)

Japanese Journal of Physics· Transactions and Abstracts. Vol. 5, No. 2. Pp. 67-101+15-24. (Tokyo: National Research Council of Japan.)

Berichte der Deutschen Chemischen Gesellschaft. Jahrgang 62, Nr. 1. Pp. vi+295. (Berlin: Verlag Chemie G.m.b.H.)

U S. Department of Agriculture. Farmers' Bulletin No. 1571: The European Starling in the United States. By E. R. Kalmbach. Pp. ii+27. (Washington, D.C.: Government Printing Office.) 5 cents.

Agricultural Experiment Station: Michigan State College of Agriculture and Applied Science. Special Bulletin No. 181: A Study of Town-Country Relationships. By C. R. Hoffer. Pp. 20. Special Bulletin No. 186: Chrysanthemum Breeding. By Elmer D. Smith and Alex. Laurie. Pp. 30. Technical Bulletin No 94: A Study of Gelatins and their Effect on Ice Cream. By P. S. Lucas and E. C. Scott. Pp. 24. (East Lansing, Mich.)

Department of the Interior: Bureau of Education. Bulletin, 1928 No. 17: Bulletins of the Bureau of Education, 1906-1927; with Index by Author, Title and Subject. By Edith A. Wright and Mary S. Phillips. Pp. ii+65. (Washington, D.C.: Government Printing Office.) 10 cents.

Proceedings of the United States National Museum. Vol. 74, Art. 1: New Diptera or Two-winged Flies from South America By J. M. Aldrich. (No. 2746) Pp. 25. Vol. 74, Art. 9. Moniezia, a Genus of Cestode Worms, and the Proposed Reduction of its Species to Three. By E. Leonard Taylor. (No. 2754.) Pp. 9+5 plates. Vol. 74, Art 20: A new Species of Trichostrongylid Worm of the Genus Cooperia from the Carabao in the Philippine Islands, with a Review of the Genus. By Benjamin Schwartz. (No. 2765.) Pp. 5+1 plate. (Washington, D.C Government Printing Office.)

Institut de France: Academie des Sciences. Annuaire pour 1929. Pp. 386. (Paris· Gauthier-Villars et Cie.)

Division of Fish and Game of California Fish Bulletin No 12. The Weight-Length Relationship of the California Sardine (*Sardina caerulea*) at San Pedro. By Frances N. Clark. Pp. 59. Fish Bulletin No. 13 Seasonal Average Length Trends at Monterey of the California Sardine (*Sardina caerulea*). By Carroll B. Andrews. Pp 13 (Sacramento, Calif.: California State Printing Office.)

CATALOGUE.

Catalogue of Scientific Books and Publications of Learned Societies. (No. 323.) Pp. 58. (Cambridge: W. Heffer and Sons, Ltd.).

Diary of Societies.

FRIDAY, MARCH 1.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10.30 A.M.—J. S. Fraser and E. D. D. Davis: Discussion on The Acute Ear: Microtia and Atresia of the External Meatus.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 5.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group). at 7—Informal Meeting.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at Engineers' Club, Manchester), at 7.—Prof. T. P. Hilditch: Recent Advances in our Knowledge of the Structure of the More Common Fats.

INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section). at 7.—W. Lawson: The Rotor Bearings of Electricity Meters.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Informal Meeting) (at Newcastle-upon-Tyne), at 7.15.—Sir Joseph Isherwood, Bart., and others: Do the Rules of Classification Societies tend to improve Shipbuilding and Engineering in this Country?

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—S. E. Hollingworth: Evolution of the Eden Drainage in the South and West.—M. Chatterjee: The Accessory Minerals in the Bodmin Moor Granite.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—L. S. Atkinson: The Control of Electric Lifts.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at 51 West Regent Street, Glasgow), at 8.—E. C. Philbrow: Inspection.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Dr. G. M. Slot: Deaths under Anæsthetics, with Special Reference to their Pathology.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Robert Robertson. Infra-Red Spectra.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (Birmingham Conference on Chromium Plating).

SATURDAY, MARCH 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Molecular Motions in Rarefied Gases (I.).

MONDAY, MARCH 4.

ROYAL SOCIETY, EDINBURGH, at 4.30.—Prof. Hans Przibram: Quanta in Biology.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Dr. A. R. Short: Recent Literature concerning the Origin of Species.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS (at Geological Society), at 6.—H. R. Lordly: The Waterproofing of Concrete Structures.

INSTITUTION OF AUTOMOBILE ENGINEERS (Western Centre) (at Merchant Venturers' Technical College, Bristol), at 6.45.—A. H. R. Fedden: Air-cooled Engine Repairs and Layout.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Loughborough College), at 7.—G. L. B. Hall: Lubrication.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—L. J. Hunt and others: Discussion on Variable-Speed Alternating-Current Motors.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—Capt. J. M. Donaldson (Power Systems), J. G. Hines (Telephone Systems), and others: Discussion on The Anticipation of Demand, and the Economic Selection, Provision, and Layout of Plant.

HUNTERIAN SOCIETY OF LONDON, at 7.30.—Prof. A. W. Sheen: Some Aspects of the Surgery of the Spleen (Hunterian Oration).

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Dr. L. Hill: Modern Methods of Heating and Ventilation.

ROYAL SOCIETY OF ARTS, at 8.—Sir Thomas M. Legge: Thirty Years' Experience of Industrial Maladies (Shaw Lectures) (III.).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—Prof. A. R. Ling: Recent Advances in the Chemistry of Polysaccharides and Allied Compounds.

SURVEYORS' INSTITUTION, at 8.—F. L. Thompson: Recent Developments in Town Planning.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Mrs. Gordon. Gallien, J. W. Cornwall, and C. C. Rose: The Kalambo River and Falls.

TUESDAY, MARCH 5.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. J. G. Forbes: Past and Present Diphtheria in England and Wales, with Special Reference to the London Metropolis (III.).
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: Evolution and the Problem of Species (VI.).
ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—B. N. Schwanwitsch: Studies on the Wing-pattern of *Catagramma* and Related Genera of South American Nymphalid Butterflies.—Dr. R. Broom: Note on the Milk Dentition of *Australopithecus*.—J. W. Low: Contributions to the Development of the Pelvic Girdle. III. The Pelvic Girdle and its Related Musculature in Monotremes.—J. S. Dunkerly: A Note on Parasites and the Natural Selection Theory.—S. Hirst: Additional Notes on Australian Mites of the Family Trombidiidæ, with Descriptions of New Forms.
INSTITUTION OF CIVIL ENGINEERS, at 6.—C. Gribble: Impact in Railway Bridges, with Particular Reference to the Report of the Bridge Stress Committee.
LONDON NATURAL HISTORY SOCIETY (at Winchester House), at 6.30.—W. H. Spreadbury: Common Birds of London's Country.
INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—E. B. Wedmore, Dr. W. B. Whitney, and C. E. R. Bruce: An Introduction to Researches on Circuit Breaking.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—W. L. Shand: Pictorial Impressions in Italy.
INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Broadgate Cafe, Coventry), at 7.15.—W. S. Ascough: Pistons.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.
INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.45.—A. E. L. Chorlton: The Heavy Oil Engine on Road and Rail.
ROYAL SOCIETY OF MEDICINE (Pathology Section) (Laboratory Meeting in Pathological Department, St. Thomas's Hospital Medical School), at 8.—J. Bamforth: Two Cases of Purpura with Unusual Blood Pictures for which Splenectomy was Performed.—R. J. V. Pulvertaft: Experiments with Streptococcal Toxin and Hæmolysins.—J. O. Oliver: Group Complement Fixation with the Gram Negative Cocci.
ROYAL SOCIETY OF MEDICINE (Orthopædics Section), at 8.30.—Dr. M. Smith-Petersen, Sir Robert Jones, and others. Discussion on The Diagnosis and Treatment of Low Back Pain.
TELEVISION SOCIETY.—Annual General Meeting.

WEDNESDAY, MARCH 6.

ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—Dr. R. Campbell Thompson: Assyrian Remedies for Diseases of the Ears.
GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. M. M. Ogilvie Gordon: The Structure of the Western Dolomites (Lecture).
NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (in Demonstration Room, Science Museum), at 5.30.—H. O. Clark: A Comparison between French and English Windmills.
INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Capt. P. P. Eckersley and A. B. Howe: Single Wave-length Working.
WOMEN'S ENGINEERING SOCIETY (at 41 Cadogan Square), at 6.—Lady Bailey: Flight round Africa.
UNIVERSITY OF GLASGOW ALCHEMISTS' CLUB (at Glasgow University), at 7.—Annual General Meeting.
INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Caxton Hall), at 7.—Dr. B. J. Owen: The Desiccation of Vegetable Material.
SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (Annual General Meeting) (at Chemical Society), at 8.—A. L. Andrew: The Cryoscopic Method for the Detection of Added Water in Milk.—Christine Mary Fear: The Alkaloid Test for Tannin.
ROYAL SOCIETY OF ARTS, at 8.—T. Purvis: Commercial Art: its Value in Business and Art.
ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

THURSDAY, MARCH 7.

ROYAL SOCIETY, at 4.30.—Prof. T. M. Lowry and A. G. Nasini: The Molecular Dimensions of Organic Compounds. Part I. General Considerations.—A. G. Nasini: The Molecular Dimensions of Organic Compounds. Parts II. and III.—Prof. W. A. Bone and R. P. Frazer: A Photographic Investigation of Flame Movements in Carbonic Oxide-Oxygen Explosions.—H. S. Patterson, Prof. R. Whytlaw-Gray, and W. Cawood: Some Observations on the Condensation of Water on Smoke Particles; The Process of Coagulation in Smokes; The Electrified Particles in Smokes; The Structure of Complex Smoke Particles.—*Papers to be read in title only*:—J. G. Semple: Cremona Transformations of Space of Four Dimensions by Means of Quadrics and the Reverse Transformations.—T. L. Ibbs and A. A. Hirst: The Thermal Conductivity of Gas Mixtures.—D. M. Newitt, B. J. Byrne, and H. W. Strong: Equilibrium in the System Methyl Alcohol-Hydrogen-Carbonic Oxide.—Prof. W. A. Bone, F. R. Weston, and D. A. Winter: Further Experiments on the Combustion of Well-dried Carbon Monoxide and Oxygen Mixtures. Part III.—Dr. E. K. Rideal and O. H. Wansbrough-Jones: An Investigation on the Combustion of Platinum.—R. W. Ditchburn and F. L. Arnot: The Ionisation of Potassium Vapour.—Prof. O. W. Richardson and P. M. Davidson: The Spectrum of H_2: the Bands Analogous to the Parhelium Line Spectrum.—R. C. Johnson and R. K. Asundi: A New Band System of Carbon Monoxide.—Prof. H. A. Wilson: The Theory of Cracking Petroleum.—Prof. T. H. Havelock. The Dispersion of Double Refraction in Quartz.—Prof. A. Fowler: The Arc Spectrum of Silicon.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Prof. E. B. Verney: Polyuria (Goulstonian Lectures) (I.).
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Rev. W. H. Draper: The Use of Language and its Difficulties.
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—C. N. H. Lock: Airscrew Body Interference.
SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (Annual Meeting) (at Bristol University), at 7.30.—Chairman's Address.
INSTITUTE OF METALS (London Local Section) (at 83 Pall Mall), at 7.30.—W. T. Griffiths: 'Theory,' 'Practice,' and Nickel.
INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre—Dublin) (at Trinity College, Dublin), at 7.45.—E. S. Ritter: Picture Telegraphy (Lecture).
CHEMICAL SOCIETY, at 8.—F. G. Mann: The Stability of Complex Metallic Salts.—A. B. Manning: The Determination of Unsaturated and Aromatic Hydrocarbons in Light Oils and Motor Spirits.—S. Glasstone: Studies of Electrolytic Polarisation. Part VII. Complex Cyanides. (*a*) Silver. Part VIII. Complex Cyanides. (*b*) Copper.
INSTITUTE OF CHEMISTRY (Manchester and District Section) (at Manchester).—Annual General Meeting.

FRIDAY, MARCH 8.

ANDERSONIAN CHEMICAL SOCIETY (at Royal Technical College, Glasgow), at 3.15.—W. H. Nuttall: Rubber and its Commercial Applications.
ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.—W. H. Moreland: The Indian Peasant in History.
ROYAL ASTRONOMICAL SOCIETY, at 5.—Prof. S. Chapman: Solar Streams of Corpuscles: their Geometry, Absorption of Light, and Penetration.—N. Goryatscheff: Occultations of Stars by the Moon, observed at the Tomsk University Observatory during the Year 1928.—Prof. S. Chapman and V. C. A. Ferraro: The Electrical State of Solar Streams.—Y. Ohman: Astronomical Consequences of the Polarisation of Fluorescence.—W. H. McCrea: The Hydrogen Chromosphere.—C. L. Janssen: Provisional Elements of the Binary System β. G.C. 12307.
IMPERIAL COLLEGE CHEMICAL SOCIETY (in Main Chemistry Lecture Theatre, Royal College of Science), at 5.—Dr. N. V. Sidgwick: Chemical Linkage.
PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Dr. E. Griffiths and J. H. Awbery: The Dependence of the Mobility of Ions in Air on the Relative Humidity.—Prof. A. M. Tyndall: Some Unsolved Problems relating to the Mobility of Gaseous Ions—followed by a General Discussion on the Mobility of Ions.
ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.
SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (Annual Meeting) (at Liverpool University), at 6.—L. O. Newton: Boiler Feed Water.
MALACOLOGICAL SOCIETY OF LONDON (in Zoological Department, University College), at 6.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. A. Hall: Bromide Papers.
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—S. H. Hole: Road Transport (Chairman's Address).
LEICESTER LITERARY AND PHILOSOPHICAL SOCIETY (jointly with Leicester Association of Engineers) (at Secular Hall, Leicester), at 7.30.—Dr. J. Newton Friend: Science in Antiquity.
INSTITUTE OF METALS (Sheffield Local Section) (at Sheffield University), at 7.30.—D. F. Campbell and W. S. Gifford: Progress in Electric Furnaces.
OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Milton Hall, Manchester), at 7.30.—S. T. Kinsman: The Fastness to Light of Lake Colours.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. T. F. Tout: The Place of Women in Later Medieval Civilisation.

SATURDAY, MARCH 9.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Molecular Motions in Rarefied Gases (II.).

PUBLIC LECTURES.

FRIDAY, MARCH 1.

UNIVERSITY COLLEGE, at 5.15.—Dr. F. A. Freeth: The Four Component System in Peace and War.

SATURDAY, MARCH 2.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Prof. J. R. Ainsworth Davis: English Food, Past and Present.

MONDAY, MARCH 4.

KING'S COLLEGE OF HOUSEHOLD AND SOCIAL SCIENCE, at 4.45.—Sir Alan Cobham: Adventures in Empire Flight.
LEEDS UNIVERSITY, at 5.15.—Prof. D. M. S. Watson: Animal Flight.
UNIVERSITY COLLEGE HOSPITAL MEDICAL SCHOOL, at 5.30.—Dr. A. M. Ramsay: The Eye in General Medicine. (Succeeding Lectures on Mar. 6 and 8.)
EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—A. W. Street: Recent Developments in the Marketing of Agricultural Produce.

TUESDAY, MARCH 5.

UNIVERSITY COLLEGE, at 5.30.—Prof. Karl Pearson: The Heredity of Albinism, illustrated by Recent Work on Albino Dogs and their Offspring.

THURSDAY, MARCH 7.

UNIVERSITY COLLEGE, at 5.15.—Prof. Hans Przibram: Concerning Laws in Animal Morphology. (Succeeding Lectures on Mar. 11, 14, and 18.)—At 6.—S. A. Hill-Willis: Concrete Roads.
40 TORRINGTON SQUARE, W.C.1, at 5.30.—N. B. Jopson: The Early Civilisation and Religion of the Slavs.

FRIDAY, MARCH 8.

KING'S COLLEGE, at 5.30.—C. J. Gadd: Assyrian Studies in the Present and Future.
SURVEYORS' INSTITUTION, at 5.30.—Prof. J. S. Huxley. Heredity and Society (delivered in connexion with the Institution of Professional Civil Servants).

SATURDAY, MARCH 9.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—R. W. Sloley: The Cave-Artists of the Stone Age.

SATURDAY, MARCH 9, 1929.

CONTENTS.

Land and Industry.

THE very heavy imports of foodstuffs into Great Britain and the urgent need for increasing the home production of food have been emphasised with wearisome iteration these many years past. A study of the trade returns for 1928 shows clearly enough that the position in this respect is getting worse. But our dependence on other countries to save us from starvation is only one part of the story. There are many other collateral factors of vital consequence. For example, it is not well that nine-tenths of our population should be entirely urban, completely exiled from the land, and wholly bereft of any land interest whatever. We may not all agree with what Mr. Galsworthy says about 'town blight,' but no one who has seriously thought about the matter, no one who has any appreciation of the teaching of history, can doubt that this entire exclusion from the land and all that it means is a potent source of national weakness, or at least of national one-sidedness.

Then, again, there is the vitally important question of leisure and its proper use. This has been hitherto a little neglected by economists, and yet, with the comparatively short hours of work now in vogue, it is a matter of the utmost moral and economic significance ; the more so, in view of the increasing monotony of the greater part of the factory and office work of to-day, and mainly carried on indoors. These considerations point to the supreme need for a more natural and outdoor form of recreative work, such as would be provided by a land interest, as a powerful antidote to the present indoor monotony of work and the general artificiality of town life. The national love of outdoor sport, if sufficient facilities could be provided for its adequate expression and exercise, may be thought sufficient mitigation. But always there are more spectators than players, and we believe that there are many of both sexes and of all ages to whom some kind of land interest would make a more powerful appeal, and would certainly prove more useful and economically stronger. It is a pity that the allotment movement of the War period has not been more vigorously continued and extended since. It was a great deal better than nothing, though far from being the best thing of its kind that could be provided. The national housing programme offered the opportunity for something vastly better. That opportunity has been missed so far.

In fact, despite the very obvious and rather

disconcerting factors in our modern industrial civilisation noted above, very little has been done, at all events in Great Britain, where it is perhaps more urgently needed than in any other country, to counteract what must be described, without exaggeration, as a serious social evil. We have had, it is true, much talk of 'back to the land,' really a fatuous and useless shibboleth in England; many acres of small-holding legislation, for the most part derelict and only applicable to a small minority; and endless discussion of agricultural policies leading to little or nothing.

We shall never be a nation of peasant proprietors despite the panegyrics of Mill, Sismondi, and others on that very admirable ideal; and therefore it might be advisable to look for something else, less drastic and complete, but more practicable, let us hope. The suggestion has been made not infrequently in recent years that a partial return to the land would be the best, a part time recreative interest rather than a whole time occupation. It would be merely a modified and improved form of industry-cum-agriculture which largely characterised our economic structure in pre-industrial days, when the Lancashire weavers had their little farms and the Sheffield cutlers were noted for their culture of flowers. To-day it is a prominent feature in the United States of America, in Canada and other British dominions overseas, in many parts of Europe, and is struggling to make some headway in Great Britain, where, as already intimated, it is more urgently needed than anywhere. It means the provision of homes or homesteads worth the name, with gardens and perhaps even orchards and greenhouses, embodying not only the primeval need of shelter but also the still more primeval need of food.

So far from being original and novel, this idea goes back to Babylonian times. Within the mighty walls of that ancient city were sheltered fields and gardens to provide food in time of siege, and indeed at all times. Some day the same imperative need may be ours; and we should make provision in time. A great deal has already been done along these lines in other countries, especially in the United States, and to some extent on the Continent. It is strange indeed that the need for this sort of thing has been more clearly realised in the United States, where there is no preponderating town population and no 80 per cent dependence on foreign food; but it has been adopted over there not so much from the point of view of food supply but rather as a refreshing counter-current to modern artificiality and rush. It is a profitable hobby too, healthy, and absorbingly interesting. In the case of the smaller holdings of industrial workers, from a quarter-acre to one or more acres in extent, it is possible to pay the greater part of the rent—or, better still, the mortgage interest and sinking fund—from the garden and orchard produce, or, what comes to the same thing, save equivalent expenditure on vegetables and fruit for the home. This would appear to be a very sound financial basis on which to establish any housing policy; and there, too, is the right solution of the leisure or 'dopo lavoro' problem as it is called in Italy.

Italy has taken up the 'dopo lavoro' (afterwork) or leisure question with enthusiasm in conjunction with home food supply. It came up before the International Labour Conference at Geneva in 1924, but was discussed in Italian labour and commercial journals long before that date. In Germany the great firm of Krupps some years ago purchased estates and farms for the production of food for its employees, many of whom became the proud owners of small holdings. It is scarcely necessary to point out here that no shrewder blow could be struck at communism and general labour unrest than such a policy as this. The ownership of a little bit of one's own country is surely the safest guarantee for sound and sober citizenship and real patriotism, and gives a man something to do other than listening to street corner oratory. Several firms in Germany and Austria have followed the example of Krupps. The municipality of Vienna has based its extensive housing schemes largely on this principle of ownership and land settlement. It seems, indeed, to be the only common-sense principle on which to base any housing programme, except blocks of flats or tenements to replace slums; and possibly even this exception is not often valid. The subject presents many and varied openings and ramifications. It has an important bearing on unemployment, emigration, and land settlement.

So far, only one form of combining industry and agriculture, farm and factory, has been considered. There is not space to deal with the converse form, that of giving the agricultural worker an industrial or rather a manufacturing interest, in the form of village and cottage industries and handicrafts. This is another chapter, and is a well-known economic feature in India, also in Switzerland, Norway, and elsewhere. It is being taken up in Canada, for example, in Quebec, where the need for some occupation in bad weather and during the dark days of winter is very evident. In these and other ways a people may be made to work harder

without knowing it; or, knowing it, they enjoy it. It is doubtful if, in the sterner, strenuous, and fiercely competitive days ahead—if they have not already arrived—we can much longer afford to neglect this vital matter of using even our leisure to the best purpose. At least greater opportunity for such could be afforded, and is within the range of practical politics.

The question of leisure occupation for those already in work, important as it is, almost fades into insignificance, however, beside the greater question of unemployment. So far as the programmes of the chief political parties have been revealed in view of the coming election, there does not appear to be anything refreshingly original or practically effective in contemplation to deal with this great evil; and it is not, of course, pretended in this article that the suggestions herein tentatively offered contain anything very helpful by way of remedy or mitigation. It is, however, firmly believed that a vast field of employment could be opened up along the lines of land settlement, land reclamation, village industries, combined with industrial enterprise, possibly a programme somewhat similar to that adopted for the Greek refugees.

It is not possible here to go fully into this part of the subject, except to say that the land interest—allotment, small holding, or the like—could be more effectively provided in garden cities, industrial villages, and so forth, where new industries could be established, than in or near existing industrial centres where little or no land is available. In any event, the new derating concessions should be a great help in establishing industrial small holdings; and the extent to which such holdings are already used by those engaged in other occupations is revealed by a recent study of small-holding economics in one county alone, for example, Carmarthen. Nearly fifty per cent of all holdings under fifty acres are occupied by persons with non-agricultural employments, representing nearly every trade and profession; miners, general labourers, carpenters, butchers, and grocers being the chief. We are glad to know in this connexion that in some districts in South Wales, where allotments have gone out of cultivation on account of inability to pay rent for them, or purchase seeds or manures, the Society of Friends is successfully reviving allotment holdings and providing facilities for unemployed miners to work them for the production of food. There could be no better use for grants from the Central Coalfields Distress Fund, in suitable districts, than to encourage work on the land in this way.

Reform of the British Patent System.

It is clear from statements which have been made in the House of Commons during the past few months that a serious state of affairs exists at the Patent Office. On July 18, 1928, Mr. Herbert Williams stated, in answer to a question, that 6300 complete specifications were awaiting first action by the examiner and that these arrears were accumulating at the rate of 67 per week. On Feb. 26 last, in answer to a further question, he stated that the arrears now amounted to 8400 complete specifications and were increasing at the rate of 76 per week. Since about 20,000 complete specifications are filed annually, the work is therefore just over five months in arrear on the average.

Figures given by Mr. Williams in July indicate that while the number of specifications to be dealt with annually had increased by 26 per cent as compared with 1912, the strength of the examining staff had decreased by 10 per cent. This economy, at a time when the Patent Office obtains a large and increasing surplus of fees over expenditure, appears to be most unjustifiable. The present critical state of affairs could have been foreseen and provided against some years ago, for the input of patent applications has been steadily increasing since patent business became normal after the War. The public has a right to know why such steps were not taken in good time. Did the Comptroller of the Patent Office fail to warn the Minister or did the Minister fail to heed his warnings? Or is it that, as in the case of certain other technical departments, there is interposed between the Minister and the technical chief a body of administrative officials who fail to appreciate technical requirements?

Last October an important report on the reforms which are needed in the British patent system was published by the British Science Guild. This report met with an enthusiastic reception from the financial, technical, and daily press, and we understand that it has received the formal support of a number of important bodies. Asked whether the Board of Trade proposed to take any action in this connexion, Mr. Herbert Williams stated on Feb. 26 that the President of the Board proposed to set up a committee in due course to review existing patent law and practice.

While the British Science Guild Committee may be congratulated on this promise of a result arising from its labours, some disappointment will be felt at the absence of any indication that the matter will be carried through expeditiously.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of Nature. *No notice is taken of anonymous communications.]*

Soft X-Rays from Crystal Faces.

These experiments originated in an attempt to improve and extend those of Richardson and Chalklin on the generation of soft X-rays from surfaces of tungsten formed by deposition *in vacuo* on carbon (*Proc. Roy. Soc.*, A, **119**, p. 71 ; 1928). In that investigation difficulties were met with owing to the deposition of impurities on the carbon target by the bombarding process necessary to secure the requisite high vacuum. To avoid this difficulty we made a target like two doors folded together on a hinge. We could bombard this target with the doors shut, and then open it out and so make the X-ray tests on the inner surface which had been heated but not exposed to the residual gases in the tube.

The tests are made by measuring the photoelectric current generated by the soft X-rays when they fall on a nickel plate, dividing this by the primary thermionic current, plotting the fraction so obtained against the exciting voltage, and looking for discontinuous changes of slope in the resulting curves. On making this experiment we were surprised to find a large number of discontinuities extending all over the range from 20 to 560 volts. These discontinuities are mostly well defined and quite persistent, and they repeated with a second target made from a specimen of spectroscopically pure arc carbon kindly supplied to us by Dr. R. C. Johnson. In this case the carbon was so soft that the hinge could not be made, and the surface of the target was protected during bombardment by a sliding shutter made from the same carbon.

In the hope of simplifying the problem, we decided to try experiments in which the X-rays were generated by bombarding a single crystal face of crystalline carbon. Through the kindness of Prof. W. T. Gordon we were able to obtain a diamond with a large natural face and some large pieces of natural crystalline graphite. Unfortunately, the diamond was found to be unsuitable for the experiment, as an attempt to determine its electrical resistance showed it to be immeasurably high. This would suggest that little confidence can be placed in the results of Lukirsky (*Zeits. fur Physik*, **22**, p. 351 ; 1924) which were made with this substance. A repetition of his experiments with the substitution of graphite carbon for diamond in this laboratory by Miss L. P. Davies led only to data which were very difficult to interpret, and, furthermore, his results are incapable of reconciliation with the very reliable conclusions of Rudberg (*Proc. Roy. Soc.*, A, **120**, p. 385 ; 1928).

After some trials we were able to split off a piece of graphite with a surface large enough to be suitable for testing. The surface used was that at which natural graphite cleaves most easily (the 0001 plane). On testing the graphite surface between about 70 and 320 volts, seventeen discontinuities have been found, each of which either agrees with a value or with the mean of two values a few volts apart, found previously with carbon. Fifteen discontinuities which were present in this range with the carbon target are absent with the graphite target. It should be added that the surface used was by no means perfect, so that it is possible that a still further reduction in the number of discontinuities might be effected if a more perfect surface could be obtained. From these experiments there seems no doubt that the number of discontinuities from a single crystal surface is smaller than from a polycrystalline surface. It is satisfactory to note that the K level discontinuity is not one of those which disappears.

We should be grateful to any readers of Nature who could supply us with any specimens of conducting crystals suitable for these experiments. The materials must be capable of withstanding a bright red heat *in vacuo*.

O. W. Richardson.
U. Andrewes.

King's College,
Strand, W.C.2.

Soft X-Rays from a Single Nickel Crystal.

At the suggestion of Prof. O. W. Richardson, an investigation was made on the excitation of soft X-rays from a single crystal of nickel, kindly lent by Dr. H. H. Potter, of the University of Bristol. The face chosen was the [100] face and the range of potential was from 0 to 300 volts. The experiment was conducted with an all-quartz tube similar to the one used by Richardson and Chalklin (*Proc. Roy. Soc.*, A, **110**, p. 247 ; 1926). Curves were drawn between the applied potential and the energy of the soft X-ray excited as measured by the usual photoelectric method. When the bombarding current was maintained at about 1·5 milliamperes, definite and strong inflections appeared at 63·8, 72·2, 106·2, and 116·0 volts. A very weak inflection was also noted at 94·4 volts. No other inflections were obtained. If, however, the thermionic current was increased to about 3 milliamperes, there appeared also, besides the four strong ones noted above, weak inflections at 129·0, 144·8, 155·9, 179·9, 186·0, and 217·7 volts (all of which appear in the results of Thomas for nickel), while the inflection at 94·4 volts became stronger.

As could be seen from the published microphotograph of the surface of a nickel crystal by Davisson and Germer (*Phy. Rev.*, II. **30**, p. 710 ; 1927), it is very difficult to obtain an ideally crystalline surface over an area of as much as 12 mm. × 6 mm. (the area used in these experiments), and there are bound to be some irregularities on the surface. It looks, therefore, very probable that when an ideal crystal surface is used only four inflections appear, these being at 63·8, 72·2, 106·2, and 116·0 volts. The first two can be associated with transitions from the $M_{II,III}$ level in the nickel atom, 63·8 volts representing the energy necessary to shift an electron from that level to the periphery of the atom and 72·2 representing the energy necessary to remove the electron altogether from the atom. The emission data of Thoraeus (*Phil. Mag.*, vii. 2·2, p. 1007 ; 1926) gives for the $M_{II,III}$ level the value of 73·2 volts. In the same manner, the values 106·2 and 116·0 volts may be associated with similar transitions from the M_I level, the energy of which is 112·4 volts according to the same authority.

It is well known that when a metal target (non-crystalline) is heated strongly by electronic bombardment, the surface looks altered, probably because of the formation of small metallic crystals. These crystals may in some manner be the origin of the large number of inflections observed by recent investigators. Further, it would be interesting to determine the effect of a crystal surface on the secondary emission of electrons, since Prof. Richardson has shown that there is a close similarity between the excitation of soft X-rays and the emission of secondary electrons (*Proc. Roy. Soc.*, A, **119**, p. 531 ; 1928). Farnsworth (*Phy. Rev.*, II. **31**, p. 419; 1928) has

already reported that the characteristic secondary electron emission inflections from a crystal surface are different from those of ordinary metals between 0 and 40 volts. It is proposed to repeat the soft X-ray experiments with other crystals, as also to investigate the secondary electron emission from crystals further at higher potentials. My sincere thanks are due to Prof. Richardson for his kind help and encouragement, and to Dr. H. H. Potter for the crystal of nickel.

S. RAMACHANDRA RAO.

Wheatstone Laboratory,
King's College, London, W.C.2,
Jan. 29.

Incoherent Scattering.

THERE are several surprising peculiarities of the phenomena of modification of wave-length in scattering, but the most striking is the rareness with which one is able to find an infra-red line to fit even approximately the frequency shifts observed. On the other hand, there are many strong infra-red lines which have no corresponding frequency shift. Moreover, there is scarcely any direct correlation of intensity even when there is a supposed match in frequency.

The idea suggested by Smekal that a molecule may subtract from or add to an incident quantum one of its characteristic energy quanta and scatter the resultant sum or difference in a single quantum is so neat and clear that it is accepted as the explanation of the scattering experiments of Raman and Krishnan and others. The most important characteristics of such a process are those just indicated which are not realised in the experiments.

Kramer's and Heisenberg's correspondence principle treatment is much more successful in accounting for the facts, and Schrödinger's wave mechanics gives an almost identical result, formally, which is on closer inspection in even better accord with experiment. The wave theory for the scattering of light of frequency ν by a system excited in two of its characteristic states—let us call them k and l—leads to terms incoherent with the incident radiation of frequencies $\nu_{kl} \pm \nu$ and with intensities proportional to the square of the quantities

$$A_{kn}A_{ln}\left[\frac{1}{\nu_{kn} \pm \nu} + \frac{1}{\nu_{ln} \mp \nu}\right](\nu_{kl} \pm \nu)^2.$$

The upper signs or the lower signs are used throughout. The A_{kn}, for example, is the matrix element $\int r\psi_k\psi_n dx$, which describes the intensity of the transition between states k and n, giving out radiation of frequency $\nu_{kn} = \nu_k - \nu_n = \dfrac{E_k - E_n}{h}$.

We see that the modified frequencies $\nu_{kl} \pm \nu$ differ from the incident ν, not by absorption frequencies (although these may also appear) but by differences between these. That is to say, only when two allowed transitions (*i.e.* A_{kn} and A_{ln} different from zero) have a common level (n) is there any intensity in the scattered frequencies $\nu_{kl} \pm \nu = \pm(\nu_{kn} - \nu_{ln}) \pm \nu$.

Examination of the data shows that the frequency shifts in scattered light can be interpreted in this way. The case of carbon tetrachloride is not the most striking, but it is perhaps the simplest which has so far been tried. Only two out of five frequency shifts coincide with known infra-red lines. These two correspond perhaps to the weakest shifted lines, while the infra-red lines are the strongest. The intensity formula indicates that the strongest frequency shifts should correspond to the frequency differences between the strongest fundamentals and the other fundamentals which end on the same level. This rule suggested the energy diagram (Fig. 1). It is believed to contain elements of reality, but should not be considered as a final and complete picture. The numbers along the full vertical lines are wave numbers of the infra-red lines due to transition indicated. The numbers by the dotted lines are the differences between levels joined, and indicate frequency shifts to be expected in scattered light. The one of 27 wave numbers would be too close to the exciting line to be observed. The others were obtained from grating and prism plates, and are probably correct to a couple of wave numbers.

The test of the theory is to compare the wave-lengths calculated from this diagram with those observed. The infra-red data are from J. Lecomte, "Le Spectre infrarouge," p. 213, and the references there given. The table gives the wave-lengths which are directly connected with the frequency shifts. All the other known lines are faint, and with one exception

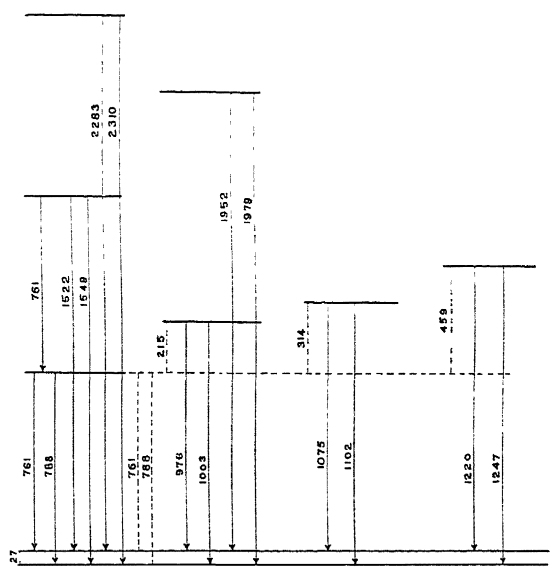

FIG. 1.

of much shorter and more uncertain wave-length. The exception is the weak line observed by Marvin at 15 μ. Its interpretation is not yet definite. The others are explicable as overtones or combinations of the levels shown. In fact, just those combinations appear which, according to the wave theory, indicate the possibility of the modified lines actually observed.

TABLE.

Calc. (μ)	13·14	12·69	10·24	9·97	9·30	9·07	8·20	8·02	6·57	6·46
Obs. (μ)	13·10	12·72	10·23	9·96	9·3	9·07	8·26	8·02	6·57	6·45

The agreement is in every case well within the experimental latitude. The significance and power of the scattering experiments in unravelling infra-red spectra is very much greater than if they merely checked infra-red measurements. With their help and with more precise infra-red data it may be hoped that the vibrations of complex molecules will be interpreted. A beginning will be made in a fuller account of this work.

R. M. LANGER
(National Research Fellow).

Bureau of Standards,
Washington, D.C.,
Jan. 4.

Luminous Discharge in Gases at Low Pressure.

CONSIDERING the very minute quantities of matter required for a luminous discharge in gases at low pressures excited by electric oscillations of high frequency, this method would seem to be specially adapted for spectroscopic tests for the products from atomic disintegration, spontaneous as well as artificial. Experiments to this end were started some time ago in the Institut für Radiumforschung of Vienna and have recently been carried further in this Institute. The following phenomena, which appear to be of general interest, were observed.

In order to make the discharge pass through narrower tubes and in gases of still lower pressure than what appears to have been feasible in the experiments of Kirchner, Gill and Donaldson, and others, oscillations of still higher frequency, 10^8 cycles per second, were applied to electrodeless discharge tubes made from transparent silica. Oscillations of this frequency and of considerabble energy, 45 watts or more, can now easily be realised by means of commercial short-wave transmission valves. A luminous discharge was found to pass through tubes only 5 mm. wide, and it could be maintained even at the lowest pressure realised by means of a powerful molecular pump backed by an oil pump of the Zenco type. The pressure was then much too low to be measured on the Gaede high-vacuum gauge, reading to 10^{-5} mm. of mercury and communicating with the discharge tube through a mercury trap cooled with liquid air.

At the lowest pressure the luminosity from the gas itself within the discharge tube was very faint and bluish in colour, whereas the silica showed a strong fluorescence in blue or in blue-green. A few silica tubes gave a brilliant fluorescence in red which does not seem to have been observed before. Thermo-luminescence and after-glow of the silica were also manifest. An ultra-violet component of the latter may be assumed to give the initial ionisation required for starting the discharge after a brief interruption of the electric oscillations. Restarting the oscillations after a longer pause, the tube, when highly exhausted, generally fails to light up until ultra-violet light from, say, a cadmium spark, is allowed to fall on it.

On passing the discharge through the exhausted tube when disconnected from the pump, a curious phenomenon was observed. The luminosity rapidly increases, and from a faint blue glow takes on a white hue of increasing brightness, the manometer at the same time showing a considerable rise in pressure. Adsorbed gases cannot be held responsible for the effect, which remains unabated when the pump has been running for several hours, and is also unaffected by baking out the discharge tube for more than an hour at 600° C. in an electric furnace. The production of gas goes on at a rate of about 1 c. mm. N.T.P. per minute at very low pressure, and is noticeable even after the pressure has increased to several hundredths of a millimetre of mercury.

The only possible explanation of this phenomenon seems to be that silica is decomposed, releasing oxygen, under the action of the electric oscillations, or rather by ultra-violet light of very short wave-length generated at the discharge. Whether the active rays are the strong emission lines of oxygen itself in the far Lyman region will have to be settled by means of a vacuum spectrograph. Light transmissible through silica seems to be ineffective, since no sensible rise of pressure was noticed when the exhausted discharge tube with the oscillations off was exposed for more than one hour to the intense light from a quartz mercury lamp close to it.

The above explanation is in agreement with the results from recent observations by Gillam and Morton (*Phil. Mag.*, p. 1123, December 1928), who found the general decrease with age in the emission from quartz mercury lamps to be due to a deposit of silicon over the inside of the walls, caused by decomposition of the silica. Anyhow, my experiments prove that the presence of mercury vapour is not essential for the effect. Also, judging from the relative magnitude of the effect in both cases, one would infer that the light from the oscillating discharge is much richer in active components than the mercury light.

The light emitted from the self-generated gas was examined in the visible region by spectroscope and spectrograph, and also, in the ultra-violet, by a medium-sized quartz spectrograph, the plates showing that its spectrum is rich in strong bands, especially in the ultra-violet. Oxygen, from permanganate of potassium, when introduced into the discharge tube, gave a different light of yellow colour with a different and much fainter band spectrum which, however, very soon merged into that of the self-generated gas and took on its white colour. The explanation was found by applying a tuft of cotton-wool soaked in liquid air to the tip of the discharge tube, when the white light disappeared and was replaced by the yellow oxygen light, the manometer showing a progressive fall of pressure. On removing the liquid air the beautiful snow-white light reappeared and the pressure rose, but only by about two-thirds of the previous reduction. This proves that the oxygen, under the action of the oscillations, is more or less completely transformed into ozone, which gas is condensed at − 190°, the vapour pressure being at that temperature only a few thousandths of a millimetre of mercury. The spectrum from the white light of the self-generated gas, which is identical with that from the ozonised oxygen, must therefore represent the band spectrum of ozone with a few sharp lines from elementary oxygen superimposed. By means of a larger quartz spectrograph this band spectrum has now been resolved into characteristic groups of lines, which are at present being examined. The fluorescent and chemical effects of the 'active' radiation assumed to exist within the discharge tube will be further studied.

This method of excitation seems to be particularly adapted for the study of band spectra, whereas for the purpose mentioned at the beginning of this letter, the steady production of oxygen within the discharge tube remains a serious complication. Possibly this effect may be a contributory cause of the softening of deep-therapy Röntgen tubes and of transmission valves.

HANS PETTERSSON.

Lunds Fysiska Institution,
January.

Solutions and Heat Engines.

IN Dr. Holmyard's informed and charming review, under the title "The Theory of Atoms," in NATURE of Feb. 16, the statement is made that Hellas bequeathed to civilisation the priceless gift of logical deduction but lacked the spirit of modern science. "Everything," said Thales, "is full of gods."

The motive power of modern experimental science, without doubt, is a certain spirit but so highly diluted that it is not easily discerned: the atmosphere is so befogged with gods. The jesuitical notice, following Dr. Holmyard's, by an anonymous reviewer of Dr. Haldane's book on "Gases and Liquids," is an exemplification of this thesis. A certain school has long elected to worship van 't Hoff—nothing that is said will lead its members to examine the premises of their deity's osmotic doctrine (hypothesis). Being

disputed, it cannot be called a theory. The reviewer altogether disregards Dr. Haldane's contention that the solvent has been neglected and only the solute considered. Van't Hoff never thought in terms of water: his was a purely thermodynamic mind. The hypothesis *is* inherently unintelligible. The late Prof. FitzGerald said so long ago. There is no proof of bombardment by the solute molecules; the tendency is more and more to admit that the solute molecules, whatever their form, are anchored to the solvent: scarcely a preparation for ballistic exercise. Whence does the bombardment come in the Perrin experiment, in which only water and very minute resinous particles are in interaction?

Worship is part of our nature: a faith once imposed is all but fixed: we scarcely ever ask ourselves whether the gods held up to us be false or not. Hellas may have bequeathed to us the gift of logical deduction—it in no way follows that we have learnt to use the gift. However much of so-called science there may be in us, it is rarely in us to be scientific. The main difficulty in dealing with problems of solutions comes from the tendency to take mathematical expressions too seriously and absolutely and greatly to overrate their value: to treat them as if they had a sacred meaning rather than as devices for wrapping up and obscuring meaning. We need to get rid of gods and to put more of the holy ghost into our musings, so that they be made with method. I agree with Dr. Haldane, that in this matter of osmotic pressure we have but "engaged in idolatrous worship of ununderstood equations." In any case, the discussion of such problems should be open, not anonymous: anonymous attack should not be permissible in our society.

HENRY E. ARMSTRONG.

MAY I inquire from Prof. Armstrong whether it is jesuitical to ask Dr. Haldane to consider what the effect of the bombardment of the solute molecules will be even if I hope that his answer may, after all, be favourable to van't Hoff? Moreover, as Prof. Armstrong wishes to enter the arena, may I ask him also to consider the same question? That there is bombardment is not a subject for question unless we are prepared to give up the dynamical theory of matter. Prof. Armstrong asks, somewhat sceptically, whence the bombardment comes in the Perrin experiment. Surely what Perrin achieved was to show *visibly* that the dynamical theory is true. The particles *are* in rapid motion, and are frequently colliding, and each collision produces its expected dynamical effect. That there is bombardment is not merely a happy hypothesis; it is an observed fact. It cannot be explained away by the assertion that it is 'unintelligible.'

Prof. Armstrong, however, in spite of the evidence of his senses—for I presume he has seen Brownian motion, though perhaps he has not himself experimented with it quantitatively—wishes to ignore its effect, and suggests instead that the solute molecules are anchored to the solvent. I challenge him to show how a pressure can arise from such attachments. He must bear in mind that when there is equilibrium between the liquids on the two sides of an osmotic membrane, the solution is at a higher *external* pressure (that is the fact which is directly observed), and that attractions between molecules always act to reduce the *external* pressure.

Physical chemists do not ignore the solvent. It assists in certain cases to break up the solute molecules; and especially in strong solutions it has a great modifying influence, so that a simple 'gas' calculation is quite insufficient. We need not be surprised at this, because similar modifications are produced in gases at high pressure.

Prof. Armstrong holds strong beliefs on these questions. I urge him to put them into logical form so that others may be led into the right path. Those of us who have read his papers find no rational theory there from which osmotic pressure can be calculated. He must remember, however, that forces do not arise out of nothing like gods of ancient mythology. Let him not be afraid of an equation which, after all, is only a somewhat condensed form in which the quantitative results of our thinking can be expressed. It, of course, need not be 'idolatrously worshipped'; and, indeed, it may be dispensed with, though the alternative methods of description are not so compendious. Above all, let him learn that assertion, even when strong, is no adequate substitute for proof.

Again, I ask Prof. Armstrong to join Dr. Haldane and consider the question as to what the effect of the known bombardment of the solute molecules will be when a semi-permeable membrane is provided through which the solvent can flow if it is induced to do so.

THE REVIEWER.

Diffuse Bands and Predissociation of Iodine Monochloride.

THE absorption spectrum of iodine monochloride consists of a group of bands (group Cl*) with an upper convergence limit at about 17430 cm.$^{-1}$ corresponding to the dissociation of ICl into a normal iodine atom and a chlorine atom in the 2^2P_1 state. There is also another group (group I*) of which only two members (17446 cm.$^{-1}$ and 17570 cm.$^{-1}$) were observed by Gibson and Ramsperger. Several further members of this group have since been observed (Gibson: unpublished measurements). These are visible in the region between the convergence and the absorption maximum of the continuum of group Cl*.

We have strong evidence that the convergence limit of group I* corresponds to dissociation of iodine monochloride into normal chlorine and excited iodine atoms. A second continuum farther in the ultraviolet has also been observed and probably corresponds to this same process. The band 17446 cm.$^{-1}$ of group I* shows the fine structure clearly. The rotation lines are sharp near the head, but show a marked increase in width for large rotational quantum numbers. The next following bands of this group are diffuse and fade out in the region of continuous absorption of group Cl*. It seems very likely that this effect is of the same nature as that discovered by Henri and termed predissociation. The place at which the widening of the rotation lines begins in the band 17446 cm.$^{-1}$ corresponds within experimental error to the convergence limit of group Cl*. This suggests strongly that interaction between the Cl* continuum and the discrete states of group I* is responsible for the diffuseness.

A similar assumption has been made by Wentzel to account for the diffuseness of the lines corresponding to the higher terms of the p' series of Ca, and by Bonhoffer and Farkas and by Kronig to account for diffuse band spectra. Kronig has shown that under favourable conditions the life period of a discrete state may be so shortened by the presence of a continuum that it becomes less than the period of rotation, in which case diffuseness may be expected. Calculations were made by us using perturbations of the type considered by Kronig, which arise from the terms in the wave equation neglected in the separation of electronic and nuclear co-ordinates (see *Z. Physik*, **50**, 347; 1928). A formula has been obtained (to be published shortly by Rice) which permits a direct quantitative calculation of the width of the rotation lines when the perturbation matrices are known.

Kronig arrives at two results for the perturbations according as the quantum number n which determines the angular momentum of the electrons about the nuclear axis changes by ± 1 or remains constant in the radiationless transition. In the first case the width of the rotation line varies with the square of the quantum number j, which determines the total angular momentum. In the second case the width of the line is independent of j. Kronig has made rough estimates of the orders of magnitude of the perturbations. Using his estimates, we cannot account for the observed width of the lines of higher rotational quantum number unless we take the first case in which n changes by ± 1 and the width is therefore proportional to j^2. We have reason to believe, however, that n has the same value for group Cl* as for group I*.

It is possible, however, to account for the magnitude of the effect, even in this case, if we take into account the fact that the eigenfunctions are oscillating functions of the co-ordinates. We have made calculations, using Kronig's estimate for the electronic eigenfunctions and making very reasonable assumptions as to the nature of the vibrational eigenfunctions of the two states. The vibrational eigenfunctions are approximately sine curves. It is entirely consistent with what we know of the energy and moment of inertia of the molecule in its two states to suppose that the eigenfunctions have nearly the same wave-length and such a phase relationship as to produce a large effect. The calculations show that perturbations of the type considered by Kronig are then sufficient to account for the observed widths. The effect would be still further enhanced if the electronic eigenfunctions of the two states should coincide in a similar manner, in which case a less complete coincidence for the vibrational eigenfunctions would be sufficient to reproduce the experimental values.

G. E. GIBSON.
University of California,
Berkeley, Calif.
O. K. RICE
(National Research Fellow).
California Institute of Technology,
Pasadena, Calif.

Effect of Parathyroid Hormone on the Structure of Bone.

IN the current issue of the *Journal of Experimental Medicine* (January 1929), Bauer, Aub, and Albright have reported that the administration of the parathyroid hormone (Parathormone, Eli Lilly), to rabbits over a period of 91 days in doses up to 8 units per diem results in a depletion of the trabeculæ of bone, without gross changes in the cortex. The X-ray plates showed that the bones contained less calcium than those of control animals belonging to the same litter, whilst the blood calcium increased to about 15 mgm. per cent as compared with a normal value of 10 mgm. per cent. In similar experiments with young rats the administration of parathormone did not give a similar result, but rather increased the number of trabeculæ and the density of the bones, whilst the blood calcium did not differ appreciably from that of untreated animals under similar conditions. With cats the results were entirely negative.

All these experiments were carried out with a diet rich in calcium.

It has for some time been recognised that the diseases osteitis fibrosa and osteomalacia are not infrequently associated with tumours or hyperplasias of the parathyroid glands. For example, parathyroid adenomata were found in the case of osteitis fibrosa described in great detail by Dawson and Struthers (1923) in a communication from this laboratory. In another case of the same disease also associated with parathyroid adenomata, more recently investigated from the biochemical point of view by one of us (C. G. L.), a very marked hypercalcæmia (17 mgm. per 100 c.c.) was found, together with a negative calcium balance (see Lambie, *Brit. Med. Jour.*, 1927). It appeared possible that in these cases the primary disturbance was the existence of the parathyroid tumour resulting in an excess production of the hormone over a long period. This would cause the hypercalcæmia, the negative calcium balance, and, presumably, the removal of calcium from the bones.

In order to test this hypothesis it was thought desirable to carry out experiments to ascertain what is in fact the effect of prolonged administration of parathyroid hormone upon the structure or bones. In preliminary experiments carried out with young growing rats, kept on an ordinary diet, in which two were used as controls and two were given 10 units each of parathormone per diem for 21 days, it was found, on histological examination of the bones, that there was marked thinning of the trabeculæ in all the bones examined, especially the femora and vertebræ. In one of the two treated animals changes were also apparent in the cortex and in the epiphyseal cartilages. The bones, when dried, exhibited a greater tendency to fracture than did normal ones, and when ground up showed themselves to be more fibrous in texture. On chemical analysis it was found that the bones of the treated animals gave rise to less ash on ignition, but that the percentage of calcium in the whole bones was not significantly altered. It appears, therefore, that the inorganic ash from the treated animals actually contained more calcium than that of the untreated. This latter finding is puzzling, but may indicate a change in the form in which calcium exists in the bones of the treated animals.

These results confirm the positive findings of Bauer, Aub, and Albright as to the effect of parathyroid hormone upon the structure of bone, and it is hoped that by further experiments on these lines light may be thrown upon the pathogenesis of osteitis fibrosa, osteomalacia, and other bone dystrophies.

Bauer, Aub, and Albright (1929) *Jour. Exper Med* , **49**, 145.
Dawson and Struthers (1923). *Edin. Med Jour.*, **30**, No. 10, 421.
Lambie, C. G. (1927). *Brit. Med Jour.*, II. (Oct.) 785.

C. G. LAMBIE.
W. O. KERMACK.
W. F. HARVEY.
Research Laboratory,
Royal College of Physicians,
2 Forrest Road,
Edinburgh, Feb. 13.

Spiral Markings on Carborundum Crystals.

IN the course of another investigation, we have had occasion to examine crystals of carborundum under the microscope. These crystals were of very dark purplish colour, with often a greenish sheen. Pure carborundum is said to show little colour, and the deep colour of the crystals of commerce is attributed to a minute quantity of free carbon, which doubtless tends to distort the lattice. Certain of our crystals exhibited, on their smooth hexagonal, basal pinakoid, surfaces, striations formed of numerous curved parallel lines, some thirty or forty microns apart, and roughly equidistant. Such striations have been mentioned in the literature. We were fortunate in finding a crystal face which showed that these markings may form a rather perfect spiral. A photomicrograph of this is reproduced as Fig. 1.

It will be seen that we are here in possession of a very clearly defined fact. Very often in science our theories are sufficiently clear, while the facts are much less so. The opposite is here true.

Three crystalline modifications of carborundum have been described, all of hexagonal symmetry ; and striation by straight parallel lines occurs, and calls for no comment. Spiral forms are very uncommon in inanimate Nature, but may perhaps occur when two types of crystal architecture alternate. That the observed spiral is related to the underlying hexagonal, or di-trigonal, structure may be seen from the slight flattening of the curvatures at azimuths 60° apart. Furthermore, the markings on different crystals have an obvious relation to the margins of the crystals, when these are visible. It may be true that some carborundum crystals have a thin surface coating of silica ; but hydrofluoric acid does not affect the markings we have observed.

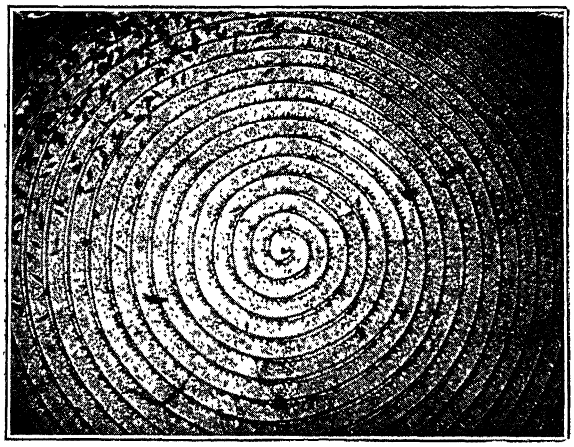

FIG. 1.

Not all specimens of carborundum exhibit such striation. This we have ourselves noted ; while Negri, who states that he examined thousands of carborundum crystals with a hand lens and measured about one hundred on the goniometer, makes no mention of surface markings.

At its broadest portions the 'line' that forms the spiral can, interpreting merely in terms of appearances, be analysed into three lines, two marginal about six or seven microns apart (which may be the margins of a shallow channel or trough), and a third, between them, about two microns from the inside line. The outside line is in parts of its length fringed by outgoing excrescences, which may be of the same nature as the minute lozenge-shaped crystals which the photomicrograph shows lying in parallel orientations 60° apart.

Before venturing to put forward a too imaginative hypothesis, we should be glad to learn what others suggest in interpretation of this unusual phenomenon.

ALAN W. C. MENZIES.
C. A. SLOAT.

Princeton, N.J.

Polarisation of Compton Scattering according to Dirac's New Relativistic Dynamics.

IN a letter to NATURE of Dec. 1, 1928 (vol. 122, p. 843), I gave a formula for the intensity of the radiation scattered at right angles first by one and then by a second electron. In this formula, unfortunately, no account was taken of the change of frequency of the radiation during the first scattering. When this mistake, which has been kindly pointed out to me by Mr. Chr. Møller, is corrected, the formula in the letter referred to is replaced by

$$I=\frac{e^8}{2m^4c^8r^2r'^2}\frac{I_0}{(1+2\alpha)^3}\left\{\sin^2\theta+\frac{\alpha^2(2+4\alpha+3\alpha^2)}{2(1+\alpha)^2(1+2\alpha)}\right\}.$$

Owing to this, the comparison of the theory with the measurements of Lukirsky comes out somewhat differently. Thus, for $\theta=0°$, the intensity is 5·3 per cent instead of 6·5 per cent of the intensity at 90°, when the wave-length is assumed to be 0 085 A.; and agreement with Lukirsky's result would be obtained with a wave-length of 0 13 A. instead of 0·14 A.

Y. NISHINA.

Institute of Physical and Chemical Research, Hongo, Tokyo.

The Language of Science.

IT has been said yet once again (NATURE, Feb. 2, p. 161) that 1 and 1 are not always 2. With great respect to Sir Oliver Lodge, I would suggest that there is here some confusion, if not of thought, at least of language. In the common use of our language, when we say 1 and 1 make 2, we imply that each unit suffers no change in being added to, or rather associated with, the other. The usual, that is, not the special physical or chemical or biological, meaning of 1 and 1 is 1 + 1, where + stands for "associated with, but involving no change in either." Thus 1 (apple or mercury globule or amœba) and 1 (apple or mercury globule or amœba) *always* make 2 (apples or mercury globules or amœbæ). When, however, in the phrase 1 + 1, the symbol + is distinctly defined to mean (1) reacts physically with, or (2) reacts chemically with, or (3) reacts biologically with, the result, *as experience shows*, need not be 2. For example, 1 + 1 = 1 when + means (1) and the units are mercury globules ; 1 + 1 = 4 when + means (3) and the units are amœbæ. In each of these cases a *change* has taken place, not a mental or an arithmetical addition.

To express any such change by saying simply 1 and 1 are 5 is to misuse our language. To go further, and say 1 and 1 are 2 and sometimes 5, is to confuse both thought and language.

GEORGE HOPE.

221 Dalkeith Road, Edinburgh.

Hamilton's Contributions to Geometrical Optics.

WE are at present engaged in preparing for the Royal Irish Academy the first volume of a collected edition of the mathematical papers of Sir William Rowan Hamilton. This volume is to contain Hamilton's contributions to geometrical optics.

If any readers of NATURE should happen to be in possession of any mathematical manuscripts written by Hamilton, we would be glad if they would communicate with one of us.

A. W. CONWAY.
University College, Dublin.

J. L. SYNGE.
Trinity College, Dublin.
Feb. 18.

Erratum in Lodge's "Energy."

ON page 65 of numerous early copies of my little sixpenny book on "Energy," published by Messrs. Ernest Benn, Ltd., there is an erroneous reference to page 61, instead of to page 44. My object in making this reference was to call special attention to the apparently mysterious formula $ipq-iqp=h/2\pi$, which I anticipate will loom large in the physics of the future.

OLIVER LODGE.

Aspects of Fossil Botany.

By Dr. D. H. Scott, F.R.S.

II. Early Floras.

Dr. Church has reminded us that "the Beginnings of Botany are in the Sea." This is undoubtedly true, whether we accept his hypothesis of a universal ocean, or hold that the surface of the cooling earth was so corrugated that seas and continents co-existed from the first. The Plankton stage, of microscopic, free-swimming organisms, postulated by Dr. Church, has left no trace in the rocks. We have, however, abundant evidence of the early presence of marine plants. Apart from some disputable Cambrian records, we have numerous well-preserved seaweeds from the Ordovician onwards. It is, of course, mainly calcareous Algæ which have lent themselves to fossilisation. The verticillate Siphoneæ, above all, form a fine evolutionary series, admirably investigated by Dr. Julius Pia, of Vienna. Their interest has perhaps scarcely been sufficiently recognised by botanists, though among geologists Prof. Garwood has emphasised the importance of calcareous Algæ as rock-builders. The Siphoneæ, however, form a line of their own, without any relation to the land-flora with which we are now concerned.

At some unknown period the transmigration to dry land took place. If we accept the theory of continents and oceans as equally ancient, it is quite probable that there may have been successive transmigrations. As we shall see, highly organised land-plants occur about contemporaneously with apparently primitive types. Dr. Bidder, in his address to Section D (Zoology) of the British Association in 1927, pointed out the probability of the early appearance of land-organisms. He regarded the occurrence of extensive beds of graphite in pre-Cambrian rocks as evidence of an abundant vegetation in land-locked waters, with every opportunity of migration on to the neighbouring shores. Thus a land-vegetation may have made an early start, and some of the descendants may have persisted among later floras. It is suggested that Hugh Miller's 'cone-bearing tree' of the Middle Devonian may have been such a survival. To quote Dr. Bidder's words: "There may be a class or classes of terrestrial animals or plants which have breathed air two or three times as long as those which left the sea in the Devonian."

We have, however, as yet no perfectly trustworthy record of land-plants earlier than the Lower Devonian. First of all there is the classical, but once disputed, *Psilophyton* of Dawson, with its rhizome, forked aerial stems, bearing thorns but no leaves, and large terminal sporangia. There seems to be little doubt that Dawson's description was essentially correct. The contemporary *Arthrostigma* was like a larger *Psilophyton*.

The oldest known land-plant with well-preserved structure is *Gosslingia breconensis*, recently discovered by Dr. Heard in the Lower Devonian of South Wales. In habit this was something like *Psilophyton*; the branches, as in that genus, had circinate tips. It is a curious fact that circinate venation, often found in these early plants, is older than the frond itself, for it occurs on thalloid branches not yet differentiated as leaves. *Gosslingia* had a well-developed vascular cylinder, considerably larger than in the somewhat later Rhyniaceæ. The wood was evidently developed centripetally, contrary, as it appears, to the direction in the family just mentioned. Stomata were detected, as in the contemporary *Psilophyton*, in which Mr. W. N. Edwards demonstrated them very clearly. The great antiquity of the typical stoma is interesting, but not surprising, for we know that this organ is common to Bryophytes and vascular plants. *Gosslingia* also possessed terminal bodies which are interpreted as sporangia.

It is unnecessary to recapitulate the characters of the Middle Old Red Sandstone Rhyniaceæ, now familiar to botanists. A word may be said as to their relation to the Bryophytes, as indicated chiefly in the somewhat *Sphagnum*-like sporogonium of *Hornea* and Halle's *Sporogonites*. Dr. Church has gone so far as to say that "*Rhynia* and *Hornea* between them present all the characters deduced as significant for early Bryophyta"; and Prof. Bower, with more caution, maintains that "the new facts are thus seen to link the Bryophytes and the Pteridophytes more closely together than ever before." We may accept this latter statement, and then the question arises whether these supposed Devonian intermediates were on the up-grade or the down-grade. Were they on the way to become full-blown Pteridophytes, or in course of reduction to a moss-like level? Here we will only recall Haberlandt's opinion that the mosses were reduced forms. At that time one asked: But reduced from *what*? Possibly the Rhyniaceæ may suggest an answer.

The late Dr. Arber, at a time when only *Rhynia* was known, took a different view, for he thought that this genus represented "a now obsolete race of Thallophyta." He was so far justified that the Rhyniaceæ in their external morphology are no more complex than some purely thalloid seaweeds, such as *Polyides* or *Pycnophycus*. It is an interesting question whether any of the other early fossils suggest an algal connexion. *Hicklingia* of Middle, and *Zosterophyllum* of Lower Old Red Sandstone age, both have a somewhat alga-like habit, and yet were probably (certainly in the latter case) vascular plants. *Pseudosporochnus* (Middle Devonian), the largest of all these plants, probably 10 ft. high, with a bulbous base, thick stem and numerous fine branches, has all the appearance of a big seaweed, but this too was a vascular plant. *Fœrstia furcata*, an Upper Devonian fossil, though fragmentary, combines algal structure with the spores and cuticle of a land-plant. As Kidston and Lang say, it "almost serves to break down any sharp distinction between Algæ and the

simplest Pteridophyta." *Milleria* (formerly *Ptilophyton*), on the other hand, "appears to approach, without reaching, the more definitely fern-like forms that come into evidence in the Upper Devonian" (Lang).

We may now leave these simpler types and pass on to definitely leafy plants, such as the genus *Asteroxylon*. The Rhynie species, *A. Mackiei*, is now well known. It will be remembered that the connexion of the associated sporangia and sporangiophores with the plant has never been proved. The German species, *A. elberfeldense*, of perhaps somewhat later age, serves to remove any doubt, for the plant bore, towards the summit, naked branches, resembling the Rhynie sporangiophores, and in two cases sporangia were found upon them. Kräusel and Weyland's species combined the external features of the form-genera *Thursophyton*, *Psilophyton*, and *Hostimella*. It differs in definite respects from *A. Mackiei*, notably in the apparent presence of a pith in the stele of the main axis. Thus *Asteroxylon* appears really to present the extraordinary combination of characters attributed to it by Kidston and Lang—the anatomy and vegetative habit of a Lycopod, with a reproductive apparatus suggesting that of some of the Carboniferous ferns. Another early plant, looking like a Lycopod, is *Protolepidodendron*, only known by its external features.

Among Kräusel and Weyland's discoveries at Elberfeld, in the Upper Middle Devonian, are the two oldest known Articulatæ, *Hyenia* and *Calamophyton*. The most interesting point is the fructification, which in each case consists of a lax cone, bearing no bracts, but only sporangiophores, which are forked and support pendulous sporangia. The absence of bracts in these 'Protoarticulatæ' supports the view of Lady Isabel Browne that these sterile organs were a later intercalation in the Calamarian cone.

The variety of Early Devonian plants was naturally far greater than the few better-known types here mentioned would indicate. For example, Prof. Lang, in his assiduous investigation of the Old Red Sandstone flora of Scotland, found eight different kinds of spore in the fish-beds of Cromarty. They run up to 400μ in diameter, and some may thus have been megaspores. One type has been identified by Kräusel and Weyland with the spores of the Elberfeld tree-fern *Aneurophyton germanicum*.

Aneurophyton was a tree-fern in habit, but its affinities are quite uncertain. All parts of the plant are known: stem, root, fronds, and, to a certain extent, the fructification. There was much secondary wood, resembling that of *Palæopitys Milleri*. Quite recently the primary wood has been discovered. It was solid and three-lobed in transverse section, recalling that of the Lower Carboniferous genus *Stenomyelon*. It is a remarkable fact that all parts of the frond show stem-structure. Only the ultimate leaflets are regarded as truly foliar; they have no vascular strand at all—hence the generic name. The sporangia are borne in clusters on special leaflets. The plant bears a general resemblance to *Eospermatopteris*, but there is no evidence of seeds. *Palæopitys Milleri* (Middle Old Red of Cromarty), as just mentioned, has somewhat similar wood-structure to that of *Aneurophyton*, but nothing is known of its habit. The structure, while not that of a typical Gymnosperm, is more like a Gymnosperm than anything else, and to that extent may justify the discoverer's bold description of it (in 1847) as a "cone-bearing tree." At any rate it is a highly organised plant to find at so low a horizon.

Returning to the Elberfeld records, we must note the remarkable discovery of a Middle Devonian *Cladoxylon* (*C. scoparium*), the oldest species known, and the only one in which the external habit and something of the fructification are shown. The complex anatomy is exactly that of the well-known species first described by Unger in 1856. The leaves are numerous, small, forked appendages, very different from the large fronds which, on anatomical evidence, appear to have characterised the Thuringian Cladoxylons. It has been suggested by Dr. Hirmer that the genus (following the analogy of *Asteroxylon*) possessed leaves of two categories, the small appendages of the Elberfeld species representing Lygnier's 'phylloids,' while the massive fronds of the later forms were true leaves derived from modified branch-systems. The sporangia of *C. scoparium* were borne on the margins of lobed outgrowths, differing in shape from the vegetative foliage. Nothing was found to support the hypothesis that *Cladoxylon* belonged to the Pteridosperms.

We have, in fact, apart from *Eospermatopteris*, no direct evidence for the occurrence of seed-plants in Devonian times. The leaves of the genus *Psygmophyllum*, which goes back at least to the Middle Devonian, are somewhat like those of the Maidenhair tree, and appear to have belonged to woody plants. One may imagine that we have in them an early race of Gymnosperms, but habit is notoriously deceptive. A fossil found in the Middle Old Red Sandstone of both Orkney and Caithness, named *Hostimella racemosa* by Lang, bears lateral bodies which may be either sporangia or seeds; no spores could be obtained from them, but neither is there any evidence of seed nature.

We now come to *Eospermatopteris*, the tree of the fossil forest of Gilboa in the State of New York. A great flood on the Schoharie Creek exposed five stumps in 1869. They were referred to Sir William Dawson, who named them as two species, *Psaronius erianus* and *P. textilis*. It turned out to be true that the plants were really tree-ferns in habit. In recent years further exposures have revealed hundreds of stumps scattered over a district $1\frac{2}{3}$ miles in length, and occurring at three different levels. The stumps attain a diameter of 3 feet or more. Portions of the stem and large compound fronds of the plants are associated with the rooted stumps. Seeds were first detected by Dr. Ruedemann in 1920. There are numerous specimens associated with fragments of the fronds. They were investigated by Miss Goldring, who has published full and excellent descriptions; to her the name *Eospermatopteris* is due. The seeds are

borne, often in pairs, on stalks; they are about 5-6 mm. long by 3 mm. broad, and are described as cupulate. They appear to be perfectly clear seeds, so far as impressions can show. Male organs, rather large terminal discs, with apparent impressions of sporangia on the lower surface, have also been observed. This, then, is the oldest seed-plant known, for the age is undoubtedly no later than Upper Devonian.

We may now briefly review the results of our rapid survey. Recent research has revealed, in the Early Devonian, vascular plants far simpler in structure than any known before. We can no longer regard these simpler types as reduced, for there are too many of them. With these primitive forms, however, much more advanced types are associated, possibly, as Dr. Bidder suggests, the survivors of an earlier land-flora.

Lignier's theory of the double origin of the leaf, from emergences forming 'phylloids,' on one hand, and from thallus branches forming true leaves, on the other, seems to find strong confirmation from the early flora, as, for example, in *Asteroxylon*. In many cases the circinate tips of thalloid branches clearly indicate incipient fronds.

On the whole, the data now available favour the rise of the land-flora from a well-developed thalloid stock of marine origin, which branched out into the two main Archegoniate lines, the mosses and the ferns.

The Progress of Marine Propulsion.

By Engineer Captain Edgar C. Smith, O.B.E., R.N.

Never since Fulton launched the *Clermont* or Bell built the *Comet* has there at any time been a fixed or standard type of machinery for all ships. Inventions, improvements, innovations have followed in rapid succession, and the history of marine engineering presents an endless and bewildering variety of engines and boilers which have been adopted one day, only to be superseded by better ones the next. With all this change and development, however, designers have never before been faced with the problem of choosing between so many rival methods of driving ships as they have to-day, each method of propulsion making by its performance or promise some claim to consideration. Modern marine engineering embraces in its scope not only steam boilers and steam engines, but also steam turbines, oil engines of various types, and also the use of electricity on an extensive scale.

One of the most notable steps in the progress of the marine engine was the adoption of compound working associated with the name of John Elder; another the introduction of the triple expansion engine by Alexander Kirk; another stage in marine propulsion was marked by the application of the Parsons steam turbine; while to-day there is an ever-increasing fleet of ships driven by Diesel oil engines. The advance made during the last sixty years will be realised by comparing the Cunard ships of 1869 with modern liners. Then, no Cunard ship used more than 30 lb. pressure in her boilers; the greatest horse-power in any ship was 4200, found in the *Scotia*; while the coal consumption was 3-3½ lb. per h.p. per hour. To-day, ships are running with 350-400 lb. pressure; the total horse-power of a big Atlantic liner is 70,000-80,000; while in the most modern steam machinery less than ¾ lb. of oil per h.p. per hour is used. At one time, Great Britain built 80 per cent of the steamships of the world. Owing to various causes, one of which is the rise of great shipbuilding yards abroad, this proportion has fallen considerably; yet the volume of construction and marine engineering remains very large, and there is no slackening of the effort to maintain our position. For a long period marine engineering was largely a matter of experience and rule-of-thumb, but to-day it is not only influenced at every stage by scientific research, but sometimes very costly large-scale experiments are made and the industry is ready to try out any new system which offers reasonable expectation of success. Very great popular interest was taken formerly in the records of the ships of the 'Atlantic ferry,' the blue riband of which has now been held for twenty-two years by the famous *Mauretania*. During the coming summer, the new German turbine-driven liners *Europa* and *Bremen* are due for completion, and it may be that for a time the Atlantic record will pass to Germany as it did some thirty years ago.

Apart from the new machinery for very large and fast ships, however, there are many developments taking place, and a few particulars of recent marine practice may be of value to those who, though not directly associated with marine engineering, may nevertheless be engaged in the study of some of the numerous problems which are connected with it. Marine engineering to-day owes very much to the mathematician, the chemist, the physicist, and the metallurgist.

Confining this article to recent steam practice, it is proposed to give a few notes on up-to-date boiler work and then refer to some recent improvements in reciprocating engines, steam turbines, and electric transmission gear. At first simply great square or oblong boxes with internal flues, or with banks of tubes in place of flues, sixty years ago the box boilers gave way to the cylindrical or Scotch boilers, and these have been used until recently almost without exception in merchant ships. Such boilers are suitable for steam pressures up to 200 lb. or even 250 lb. pressure, but with still higher pressures, marine engineers have had to follow naval engineering practice and use one or other of the many types of water-tube boilers, of which the Babcock and Wilcox and the Yarrow are favourite examples.

In the successful working of water-tube boilers, a supply of pure water free from grease or scale-forming substances is an absolute necessity. In high pressure steam vessels the condenser is

still the Achilles heel of the machinery, and any leakage of the condenser tubes is a source of great anxiety. Some of the most interesting boiler installations of recent times are seen in the new vessels of the Canadian Pacific Railway Company, such as the *Duchess of Bedford*, *Duchess of Atholl*, and *Duchess of York*. These vessels are driven by steam turbines with single reduction gear. Each of them has six Yarrow boilers working at 350-370 lb. per sq. in. with 250° of superheat; and also two Scotch boilers working at 200 lb. pressure. All the steam from the Yarrow boilers and a part of the steam from the Scotch boilers passes to the turbines, but it is the latter which supply steam to the auxiliary engines. Separate condensing and separate feed systems are used, and by this means oil which happens to pass over from the auxiliary engines is prevented from entering the Yarrow boilers. Salt and grease in high pressure boilers are things to be avoided at all costs. By the use of high pressure superheated steam in these Canadian Pacific vessels, it is expected to be able to reduce the running costs by 20-30 per cent.

While the turning of the water into steam, and the condensation of the steam and its return to the boiler as feed water, present the marine engineer with one set of problems involving questions such as the conduction and transmission of heat, the flow of cooling water through tubes and the prevention of deposits and corrosion in condensers and boilers, the burning of the fuel affords ample scope for ingenuity and experiment in another direction. Important mercantile steam vessels, like warships, have abandoned coal for oil, but now the possibilities of burning coal in the pulverised state are being explored. Reference was made to this by Sir Eustace D'Eyncourt in his paper on "Fuel for Ships," read to the Royal Society of Arts on Dec. 5 of last year.

Pulverised coal has been used in large boilers in some important power stations ashore for some time, and now in the American ships *Mercer* and *Lingan* and the British ships *Stuartstar* and *Horotata*, various pulverised coal systems are on trial. The *Mercer* was the first ship with pulverised coal to cross the Atlantic, the *Stuartstar* is the first British ship to be fitted with a pulverising plant, and the *Horotata* is the largest ship so fitted. Many firms have carried out experiments, and it is apparently only a question of time before the main problems of crushing, pulverising, distribution and burning will have been solved. There may possibly be a great future for pulverised coal for ships.

In the propelling machinery itself, many changes are being made, all with the object of improving economy and reducing running costs. The first essential for marine machinery is trustworthiness, but with present-day manufacture and design, few serious breakdowns occur in any of the various types. Triple expansion and quadruple expansion engines have been fitted for many years and, in spite of the progress of the steam turbine and the oil engine, the reciprocating engine is found in more ships than is any other engine. In triple expansion engines new valve gears are being tried, while a very promising development is the fitting of an exhaust steam turbine in series with the reciprocating engine and coupled to the same shaft through reduction gearing. Suggested by Sir Charles Parsons, but introduced first in Germany, this plan is known as the Bauer-Wach exhaust turbine system. The Anchor liner *Britannia*, a vessel of 8464 tons, built two years ago, has just had such a turbine fitted to her quadruple expansion engines, resulting in an increase of power with a reduction in oil consumption per horse-power, and other vessels are being similarly altered, among them being five P. and O. ships running to Australia via the Cape. In view of the large number of ships with reciprocating engines, it may be expected that exhaust turbines will be adopted on a wide scale.

Marine engineering has always been influenced by contemporary land practice, but up to the coming of the steam turbine no power station contained machinery comparable in size to that of an Atlantic liner. The steam turbine to some extent has reversed that position, but while the largest single unit turbines are found in the super-power houses, practice ashore and afloat tends to progress on parallel lines; higher pressures and higher temperatures being used in both cases. Then, too, marine steam turbines to-day drive the propeller shaft through reduction gearing, instead of directly, or alternatively use hydraulic or electric transmission. The introduction of reduction gearing with pinions and wheels with helical teeth cut with extreme accuracy led to a great increase in both turbine and propeller efficiency. In a presidential address delivered about two years ago, Engineer Admiral Sir Robert Dixon stated that in torpedo boat destroyers the use of gearing had led to an increase in the distance steamed per ton of oil of 14 per cent at full speed and 70 per cent at cruising speed. With the use of gearing came the introduction of the single collar thrust block invented by Michell of Australia, a solution of a difficult problem as complete as it was unexpected. In the development of the turbine, the gearing and the thrust block are seen many striking results of the successful application of theoretical investigations to urgent practical problems of ship propulsion.

For the transmission of the power of the turbine to the propeller shaft, electricity has been used extensively in the United States Navy, which tried out the system first in the collier *Neptune*, now the aircraft carrier *Langley*. This system is also found in about thirty ships with a collective horse-power of 500,000 plying on the Great Lakes. Much interest was created last year by the performances of the American Panama-Pacific Liner *California*, with turbo-electric machinery, and in view of the recent completion of the P. and O. *Viceroy of India* with turbo-electric machinery, comparative figures may be of interest. Though tried in an experimental launch, the *Electric Arc*, in 1911, and in the s.s. *Tynemount* in 1912, the electric drive has not previously been fitted in any large British ship, and the running of *Viceroy of India* will be

watched by every superintendent engineer. The *California* is 601 feet long and has a gross tonnage of more than 20,000 tons. Steam is supplied by oil-fired Babcock and Wilcox boilers at 275 lb. pressure and 120° F. superheat to two turbo-alternators, each of 8500 s.h.p. running at 2880 revolutions per minute, which supply current to the twin-screw propelling motors running at 120 r.p.m. At full power the vessel has a speed of 18 knots, and the consumption of oil on the first voyage for all purposes was 0·8 lb. per h.p. The *Viceroy of India* is 612 feet long, with a gross tonnage of 19,000 and a displacement of 25,000 tons. In her, six Yarrow boilers supply steam at 350 lb. pressure to two 9000 k.w. turbo alternators running at 2700 r.p.m. supplying current to twin screw motors running at 109 r.p.m. The speed of the ship at full speed will be 18¾ knots, while with only one alternator in use a speed of 16½ knots will be obtained. It is stated that the guaranteed consumption for propelling purposes only is 0·6 lb. per s.h.p. per hour. Besides the main generators, the *Viceroy of India* has four 500 k.w. auxiliary turbo generator sets and two 165 k.w. oil-driven sets, while for the pumps, fans, steering motors, etc., which are electrically driven, there are no fewer than forty-three circuits. This notable vessel is advertised to sail on her maiden voyage on Mar. 28. It has been announced that the new 'Super-Olympic' liner building at Belfast for the White Star Line will also have electric drive, but particulars of her machinery have not yet been published.

Progress in steam marine machinery has unquestionably been stimulated by the growing popularity of the motor-driven ship with its surprising economy in fuel. For fast ships and warships, however, the steam turbine is at present the only suitable engine, while in other classes of vessels no doubt various types will continue to be used according to circumstances. In Lloyd's Register Book the tonnage of ships above 100 tons included amounts to 65,159,413 tons gross, of which 5,432,302 tons are driven by oil engines, 9,682,063 tons by steam turbines, and 50,045,048 tons by steam reciprocating engines, while of the total tonnage 62·4 per cent burn coal and 37·6 per cent use oil either under the boilers or in the engines. Some of the steamers fitted for burning oil can if necessary use coal.

Obituary.

SIR BERTRAM WINDLE, F.R.S.

IT is with deep regret that we record the death of Sir Bertram Windle, professor of anthropology in St. Michael's College, University of Toronto, which took place in Toronto on Feb. 14. Bertram Coghill Alan Windle was born on May 8, 1858, the son of the Rev. S. A. Windle, vicar of Market Rasen, Lincolnshire. He was educated at Kingstown and Repton schools, and had a distinguished career at the University of Dublin, where he graduated M.D. and D.Sc. He was for a time Dean of the Medical Faculty and professor of anatomy and anthropology at the University of Birmingham. He afterwards became professor of archæology in University College, Cork, of which he was appointed president in 1904, holding this office from 1904 until 1919, when he went to Toronto. During his residence in Ireland he was extremely active in educational and other affairs, with results that were not always conducive to his tranquillity of mind.

In his more strictly professional studies, Windle attained considerable eminence. His contributions to anthropological literature were marked by originality and freshness of view. Besides papers in scientific journals, he was the author of a manual of surface anatomy, now in its third edition, and of "The Proportions of the Human Body," published in 1892. He was, however, almost as widely known as an archæologist as an anatomist. He published several books on prehistoric archæology, of which the best known are "Life in Early Britain" and "The Prehistoric Age." His "Romans in Britain" was of a more popular character and was based on lectures delivered in Toronto. He was elected a fellow of the Royal Society in 1899. The breadth of his interests was also shown in a series of literary guide-books, of which "Shakespeare's Country" is most likely to be of enduring value.

Windle's main preoccupation, however, outside his professional studies, was in religious questions, and especially the relations of religion and science. At the age of twenty-five he joined the Roman Catholic Church, and by far the greater part of his not inconsiderable literary output was concerned with religion. "The Church and Science" was awarded the Gunning Prize in 1917, and Windle was honoured for his writings by two popes; Pius X. made him a knight of the order of St. Gregory, and Pius XI. made him an honorary Ph.D.

NEWS has just reached us of the death on Jan. 17 at Moscow of Dr. G. S. Zaitzev, director of the Turkestan Plant Breeding Station. Beginning in 1914, Dr. G. S. Zaitzev devoted himself to serious and large-scale genetic, botanical and breeding work in cotton, occupying the position of the chief of the Division of Plant Breeding of the Golodnostepskay Agricultural Experiment Station until 1919. In 1919 Dr. Zaitzev was appointed director of the Turkestan Plant Breeding Station, where he remained until his death, which has interrupted a life full of scientific achievements in our knowledge of the cotton plant. In addition to his work at the Turkestan Plant Breeding Station, Dr. Zaitzev was engaged in the U.S.S.R. Institute of Applied Botany (Leningrad) as cotton specialist, and in the Central Asia State University (Tashkent) as professor of cotton growing at the Agricultural College. By the death of Dr. Zaitzev, the Soviet Union and the whole world have lost a distinguished scientific worker in the field of genetics and plant breeding, whose memory will be long preserved and honoured.

News and Views.

The following names of scientific workers and others associated with scientific activities appear in the New Year's honours list, which, owing to the illness of His Majesty the King, was not issued until Mar. 1: *Barons :* Sir Jesse Boot, for services in the promotion of education; Sir Berkeley Moynihan, president of the Royal College of Surgeons. *Knights :* Prof. J. A. Fleming, emeritus professor of electrical engineering, University College, London; Mr. G. A. Julius, chairman of the Council for Scientific and Industrial Research, Commonwealth of Australia; Col. T. F. Purves, Engineer-in-Chief, Post Office; Mr. A. V. Roe, for distinguished services to British aviation; Sardar Jogendra Singh, Minister for Agriculture, Punjab; Lee ah Yain, Minister for Forests, Burma; *Companion of Honour :* Lady Florence Elizabeth Barrett, Dean of the London School of Medicine for Women and president of the Medical Women's International Association. *C.B. :* Sir Walter Morley Fletcher, secretary of the Medical Research Council; Dr. G. F. Hill, Keeper of the Department of Coins and Medals, British Museum. *C.M.G. :* Mr. F. C. Madden, Dean of the Faculty of Medicine, Egyptian University, Cairo. *K.C.I.E. :* Sir Thomas Middleton, lately member of the Royal Commission on Agriculture in India. *C.I.E. :* Mr. R. S. Finlow, Director of Agriculture, Bengal; Mr. N. N. Gangulee, lately member of the Royal Commission on Agriculture in India; Mr. J. A. Madan, lately joint secretary to the Royal Commission on Agriculture in India; Mr. W. Mayes, Chief Conservator of Forests, Punjab; Mr. F. W. H. Smith, lately joint secretary to the Royal Commission on Agriculture in India. *G.B.E. :* Sir William McCormick, chairman of the University Grants Committee and of the Advisory Council of the Department of Scientific and Industrial Research. *D.B.E. :* Prof. Anne Louise McIlroy, professor of obstetrics and gynæcology, Royal Free Hospital School of Medicine for Women, University of London. *C.B.E. :* Prof. Winifred Cullis, professor of physiology, London (Royal Free Hospital) School of Medicine for Women; Mr. R. Hewison, late Director of Agriculture and Forests, Sudan Government; Mr. W. Nowell, Director of the Amani Research Institute, Tanganyika Territory. *O.B.E. :* Mr. G. E. Hunt, lecturer in engineering, Gordon College, Khartoum; Mr. W. A. Taylor, superintending examiner, Patent Office. *M.B.E. :* Mr. G. E. Holden, technical adviser to the Dyestuffs Advisory Licensing Committee; Mr. A. J. W. Hornby, agricultural chemist, Nyasaland Protectorate.

We publish elsewhere in this issue a résumé of a detailed research on the performance of ammeters and voltmeters made by the British Scientific Instrument Research Association, of which the director is Sir Herbert Jackson. The research is of a somewhat novel type, but there can be no question about the usefulness of this kind of research to industrial undertakings, and we hope that it will be widely followed. The research was initiated by some members of the Association, who were naturally disturbed by the disparaging remarks made by a few station engineers about British switchboard instruments. They desired that a critical examination be made of the operation, appearance, and permanent qualities of British and foreign ammeters and voltmeters for use on switchboards in central electrical stations. In order to bring the research within manageable limits it was restricted in the first place to permanent magnet moving coil instruments. The research was to be impartial and thorough, the best foreign and British instruments being obtained from well-known makers.

The results of this investigation of British and other ammeters and voltmeters are satisfactory from the point of view of the British manufacturers. Naturally there is much in the detailed report which is confidential to members of the Association, but the synopsis proves conclusively that their products were at least as good as those of their American and continental rivals. The greatest value of the report, however, lies in the criticisms made freely about all the instruments and the reasons given why certain makes are more desirable than others. These criticisms should prove most useful to the designer. As a rule, design is largely a compromise: the better the instrument is made in one respect the worse it is in another. It is largely a balancing of incompatibilities, and the successful maker is the one who secures the best balance. The nature of the materials used for the instruments has been examined, and such questions as to the relative merits of aluminium and copper wire for use in winding the coils is fully discussed. To manufacturers this kind of research is of the greatest value, and we congratulate the Association on its report.

Reference is made in the *Times* of Mar. 2 to a biennial fibre plant to which the name 'Brotex' has been given. The plant is being grown on a small scale near Totnes in South Devon, and it is claimed that in less than eighteen months from planting it will produce fibre for textiles, cellulose for paper-making, and seed containing oil suitable for cattle food. That a plant with so many desirable qualities, which will survive the winter in the south of England, should only now have been brought to notice, is somewhat remarkable and merits further investigation. It is stated that the plant grows to a height of about 10 feet in the course of 15-18 months, but nothing is said as to the soil exhaustion that is likely to take place with a crop of this kind, nor is it pointed out that land suitable for such a crop is somewhat limited in the south-west of England.

The "evolution of the plant" has not been disclosed, pending application for patents, though it has been stated elsewhere to be of hybrid origin. It is known, however, that it belongs to the genus *Lavatera* of the family Malvaceæ, and the plants now being grown in Devonshire very closely resemble a species which is a native of the Canary Islands, a plant which would certainly be hardy only near the warm south-

west coast of England in normal winters. The mallow family contains many well-known fibre-yielding plants, such as *Abutilon Avicennæ* (the source of Chinese jute), *Hibiscus cannabinus*, *Sida rhombifolia*, etc., and in some cases the seeds are also of value for cattle food. None of these plants is hardy in Great Britain, and even *Lavatera arborea*, which is the only *Lavatera* found in England, will only succeed well near the coast. If, therefore, 'Brotex' can be proved to be of hybrid origin, not only will it be of scientific interest to know its parentage, but it will also be of material importance to know whether it will regularly produce fertile seed in Great Britain. Moreover, it is of importance, from the commercial aspect, to know whether the fibre is superior to jute and hemp, with which fibres we understand the market is already fully supplied.

A timely article by Sir Oliver Lodge appears in *The Nineteenth Century* for March on the philosophy of "the genius who now lives among us and whom we call Eddington," as expressed in the latter's recent book, "The Nature of the Physical World." After expressing his agreement with the greater part of Eddington's thesis, Sir Oliver proceeds, in a perhaps unnecessarily apologetic manner, to deal with one or two contentions against which, as he expresses it, "I politely and reasonably rebel." The points which he discusses are respectively the tendency to regard the subject matter of science as confined to quantities which can be measured, and the abandonment of the notion of force in the descriptions of field physics. On the second point Sir Oliver affirms his belief in the reality of a physical force exerted by the strained ether on a body placed in a gravitational field. Eddington, in company with all orthodox relativists, prefers to express the facts in terms of the geometrical properties of the field. To a large extent, if not wholly, the difference here is merely verbal, but the first point, concerning the essential character of science, deals with more fundamental issues. The suggestion that phenomena or ideas which cannot be measured are not amenable to scientific treatment has taken immediate root in the minds of philosophical writers, and its foliage seriously threatens the survival of the finer blooms of thought which have been reared with much greater difficulty.

The simplicity of this false generalisation has gained for it a rapturous welcome from philosophers bewildered by the headlong advances of modern physics, and the relations between science and religion in particular are in consequence viewed in an entirely false light. The subject matter of science is the common experience, obtained through the five senses (the so-called *observations*), of the generality of observers. The purpose of science is to record and correlate such observations. Measurement may—in fact, does—assist both the recording and the correlation, but it does not dominate them. It is not, for example, exclusively employed—nor can it probably ever be—in recording the behaviour of a spider placed in a hive of bees, or in correlating the movements of swallows with the declination of the sun, yet these activities are certainly fair game for scientific investigation. A careful perusal of Eddington's book will show that it contains no specific warrant for the misconception, but if, as we believe, a writer of outstanding authority should guard as much against misinterpretation by the casual as by the meticulous reader, he can perhaps not be wholly absolved from responsibility for its prevalence. That, however, is of secondary importance. What is chiefly to be desired is that the true nature of science shall be clearly understood, and Sir Oliver Lodge's article should help considerably towards this end.

The eighth Annual Report of the National Institute of Industrial Psychology shows a steadily progressive increase in the interest taken by firms in the application of the principles of physiology and psychology to industry. The range of the Institute's investigation services during 1928, as judged by the fees received, has expanded by 29 per cent in comparison with the previous year. A most diverse array of activities is represented by the list of investigations, which include spinning, the manufacture of electric-light fittings, pickles, jam, and soap, the selection of staff and the layout of large stores, to mention but a few. There has also been growth in the other departments of the Institute's work; for example, in vocational guidance, research, and education. It is hoped during 1929 to inaugurate a new department for the purpose of applying to the problems of the home those principles which have been found useful in other fields. The second part of the report gives an outline of some of the investigations undertaken during the year. The third part records the research work for the year; this includes experiments in vocational guidance in London and Fife, an inquiry into occupations suitable for the blind, and a varied number of researches initiated or continued with the grant given by the Laura Spelman Rockefeller Memorial. It is clearly a record of most important and useful work.

Prof. J. Reilly and D. T. MacSweeney give an account, in the *Proceedings of the Royal Dublin Society* for January, No. 15, of the work of William Higgins, whose book, published in 1789, "A Comparative View of the Phlogistic and Antiphlogistic Doctrines," contains some interesting speculations on chemical combination. The work is the first defence of the new views of Lavoisier in the English language and was written in answer to Kirwan's "Essay on Phlogiston." Higgins' work, according to Reilly and MacSweeney, contained the fundamental germs of the chemical atomic theory, and had it not been neglected it would have led to much that Dalton afterwards put forward. It is to the genius and industry of Dalton, and the encouragement and friendly criticism of his contemporaries, that the main credit for the establishment of the theory must be ascribed. Higgins' work (which is based on experiment and is by no means purely speculative) is particularly interesting in its attempt to represent affinities as well as combining proportions, a side of the subject which was, perhaps wisely, entirely

(*Continued on p.* 385.)

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Reviews.

Population and Depopulation.

(1) *The Balance of Births and Deaths.* Vol. 1: *Western and Northern Europe.* By Robert R. Kuczynski. (The Institute of Economics of the Brookings Institution.) Pp. xii + 140. (London: George Allen and Unwin, Ltd.; New York: The Macmillan Co., 1928.) 10*s*. net.

(2) *The Shadow of the World's Future: or the Earth's Population Possibilities and the Consequences of the Present Rate of Increase of the Earth's Inhabitants.* By Sir George Handley Knibbs. Pp. 131. (London: Ernest Benn, Ltd., 1928.) 10*s*. 6*d*. net.

AT the World Population Conference held at Geneva in 1927, one might observe a contrast in viewpoint of the very greatest interest. The delegates from the United States were much concerned with the imminence of the dangers of over-population, while the majority of European speakers, at least those who spoke with authority on their own national statistics, pointed out in almost monotonous succession that their birth rates either had already fallen or would soon fall below the level necessary to maintain stationary populations. Generally speaking, northern Europe has seen the end of the period of population expansion. Is it possible that the American average of 39 to the square mile is more impressive of over-population than the European average of about 300?

In the preface to his book, Sir George Knibbs says (p. 5):

"... it shows that the menace of the present rate of growth of those inhabitants is most serious. This rate is of the order of about 1 per cent per annum."

Mr. R. R. Kuczynski, on the contrary, remarks in his introduction:

"In case, then, that natality does not again increase, the population of England is bound to die out no matter how low mortality may be reduced. And this state of affairs is by no means confined to England. Conditions are about the same in Germany, and only slightly better in France."

The scope of the two books is very different. Sir George Knibbs considers the earth as a whole; Mr. Kuczynski takes northern and western Europe, while succeeding volumes of his series will deal with other regions. "The Shadow of the World's Future" is to influence national policies in respect of population, migration, and food production: "The Balance of Births and Deaths" is concerned with a detailed statement of the relevant statistical facts, collated for the whole group of countries considered. It confines itself strictly to the existing tendencies in the growth or decline of populations; whereas the rate "of the order of about 1 per cent per annum" is practically the only statement on this subject which seems necessary for "The Shadow of the World's Future." One book is scientific; the other, political.

(1) To take the scientific book first. It has four short chapters on "Birth Rates," "Fertility Rates," "Net Reproduction Rates," and "Present and Future Tendencies," followed by four long, and largely tabular, appendices. Fertility rates are birth rates based on the numbers of women actually available for reproduction. They lead to gross reproduction rates, giving the number of live daughters born per woman. For 1927 the value for Germany has fallen to 1·00 and for England to 0·98. Even with no mortality in infancy and childhood these figures are incompatible with biological increase. For the whole area in 1926 the value is 1·12.

In the net reproductive rates allowance is made for mortality; the figures may, in fact, be read as the actual births expressed as percentages of those needed to maintain a stationary population. The estimates for 1926 are: for England 88, Germany 89, France 94, Sweden 95, Denmark 110, Finland 109, and for the whole area about 93. These values also are falling rapidly, for in 1927 the estimates are: France 91, Germany 83, England 82.

The main points, which are being but slowly apprehended in Great Britain, are brought out with perfect lucidity. For example, that the present populations have an unusually large proportion of persons of reproductive age, and unusually few of the elderly; that the course of the changes in

reproduction has not been appreciably changed by the War; and that, since the mortality rates of persons above the reproductive age are without effect upon future population growth, the present tendencies to decreasing population can only be appreciably altered by increasing fertility.

(2) Sir George Knibbs's fears seem to be centred upon somewhat improbable prospects of the increase in the world's population. He allows that the earth's resources, if wisely exploited, would support about 7800 millions of human beings. This seems a very handsome allowance, being four times the total existing world population. Trouble is anticipated (p. 118) from "the mere increase in population, coupled with the fact that Man's moral development has not kept pace with scientific knowledge." The threatening shadow sometimes takes the appearance of a bogy (p. 119):

"We are rapidly approaching numbers that make the problem a stupendous, aye, an appalling one."

Should 2000 millions induce more stupor than 1900 millions?

The chapter on the world's cereal and food crops is of course written on the assumption that there is an immediate prospect of the demand for food outrunning the supply. No evidence is adduced that this is so, and the evidence to the contrary is ignored entirely. It might be strongly argued that the situation at present and the prospects of the immediate future indicate a systematic over-production of foodstuffs. Agriculture throughout the world is a depressed occupation in the sense that the worker on the land works harder for a lower economic recompense than the worker in any other industry. In agriculture the crops which pay best are either luxury foods or not food crops at all. Falling food prices have caused an increased consumption per head in most countries, but the increase is naturally least in the staple foods and greatest in the delicacies. What agriculture needs is higher prices for staple foodstuffs, relatively to the cost of buildings, clothes, and machinery, but with new areas still apparently yearning for agricultural development, the prospect of better prices is far off. It has indeed been calculated that the rate of increase in the supply of fixed nitrogen as fertilisers would more than suffice to meet the present rate of world population increase, without putting a single new acre under cultivation. However this may be, the supply of foodstuffs is elastic enough, it is the demand that is inelastic. From Sir George Knibbs's point of view it is, however, worth while discussing the most extravagant methods of increasing yields (p. 40):

". . . but it has recently been shown that greatly increased yields are at least temporarily attainable with cereals by transplanting. The increased yields are due to the greater root development thus obtained. The use of carbon dioxide has also led to higher yields. . . . In any case these results, *while they relieve the outlook for the immediate future* [Reviewer's italics], do not warrant any disregard for the outlook resulting from population increase."

While such diversities exist in intelligent opinion as are shown by these two books, there can be no doubt of the need for bodies devoted to eliciting the real facts, such as the British Population Society, for the parent international body of which Sir George Knibbs puts in a warm plea.

R. A. Fisher.

Old English Versions of Alchemical Texts.

The Works of Geber. Englished by Richard Russell, 1678. A new edition, with Introduction by Dr. E. J. Holmyard. Pp. xl + 264. (London and Toronto: J. M. Dent and Sons, Ltd.; New York: E. P. Dutton and Co., Inc., 1928.) 6*s*. net.

English scholars first became interested in the translation of alchemical texts in the twelfth century, when they participated with the celebrated Gerard of Cremona and other continental scholars in making known to western Europe the accumulated wisdom of the Muslim world. Prominent among them were Adelard of Bath, Walcher of Malvern, Roger of Hereford, and Robert of Chester, the last-named of whom, according to tradition, first introduced chemistry into Europe. "Since," wrote Robert, in the preface to his first translation of an Arabic alchemical treatise, in 1144, "your Latin world does not yet know what alchemy is, I will explain in the present book." The translations of this period were of course done into Latin, and the same language was the usual medium in which the adepts embodied, or embedded, their observations and ideas throughout the succeeding five centuries.

The "Speculum Alchemiæ" of Roger Bacon, the earliest alchemical work of any note by an English author, was first translated from Latin into English in 1597; it appeared under the title "The Mirror of Alchimy," and is now very rare. Printed in company with Bacon's "Speculum" and other works, in such editions as those dated 1541 (Nuremberg) and 1545 (Berne), were certain Latin texts ascribed to Geber (Jabir). These texts, which can be traced back through the first printed edition of about 1481

to manuscript versions of the early thirteenth century, were first translated into English in 1678 by Richard Russell, under the title: "The Works of Geber, The Most Famous Arabian Prince and Philosopher. Faithfully Englished by R. R. a Lover of Chymistry." The English translation was reprinted in 1686, and it has now attained the distinction, after an interval of exactly 250 years from its original publication, of appearing in a third edition, enriched with reproductions of the bold woodcuts of alchemical apparatus which embellished the Latin edition of 1545.

In an interesting preface, Dr. Holmyard points out that no Arabic originals of the text are known, so that its authenticity is unproved. After considering the available evidence bearing upon the origin of the writings, he reaches the conclusion that "whatever the future may disclose concerning them, we may safely say that they are not unworthy of Jabir and that he is worthy of them; and that we know of no other chemist, Muslim or Christian, who could for one moment be imagined to have written them." The main sections of the book are entitled: "Of the Investigation or Search of Perfection," "Of the Sum of Perfection, or of the Perfect Magistery," "Of the Invention of Verity, or Perfection," and "Of Furnaces, etc., With a Recapitulation of the Authors Experiments."

Possibly the most interesting part is the account "of the Natural Principles of Metals, according to the Opinion of Modern Philosophers, and of the Author," of "the Three Principles, viz. Sulphur, Arsenick, and Argentvive," and of the six "Metallick Bodies, which are the Effect of these Principles of Nature." The description of sulphur as "a fatness of the Earth" is suggestive of the statement of Paracelsus that "the life of Metalls is a secret fatnesse, which they have received from Sulphur, which is manifest by their flowing." The second principle, Arsenick, "needs not be otherwise defined than Sulphur. But it is diversified from Sulphur in this, viz. because it is easily a Tincture of Whiteness, but of Redness most difficultly: and Sulphur of Whiteness most difficultly: but of Redness easily." The third principle, Argentvive, or Mercury, "is a viscous Water in the Bowels of the Earth. . . . It is also (as some say) the Matter of Metals with Sulphur. And it easily adheres . . . to Saturn, and Jupiter, and Sol. . . . Therefore hence you may collect a very great Secret. For it is amicable, and pleasing to Metals, and the Medium of conjoyning Tinctures."

The metals are described in vivid terms, which suggest a close acquaintance of the writer with their properties. Gold is "Citrine, ponderous, mute, fulgid . . . under the Hammer extensible, fusible, and sustaining the Tryal of the Cupel, and Cement." Silver is "White with pure Whiteness, Clean, Hard, Sounding." Lead is "livid, earthy, ponderous, mute." Copper and iron are characterised with equal felicity; finally,

"not omitting to discourse of Jupiter, We signifie to the Sons of Learning, that Tin is a Metallick Body, white, not pure, livid, and sounding little, partaking of little Earthiness; possessing in its Root Harshness, Softness, and Swiftness of Liquefaction, without Ignition, and not abiding the Cupel, or Cement, but Extensible under the Hammer. Therefore, Jupiter, among Bodies diminished from Perfection, is in the Radix of its Nature of Affinity to the more Perfect, viz. to Sol and Luna; more to Luna, but less to Sol, as shall be clearly declared in the following. Jupiter, because it receives much Whiteness from the Radix of its Generation, therefore it whitens all Bodies not White; yet its vice is, that it breaks every Body, but Saturn, and most pure Sol. . . . And he who knows how to take away its Vice of breaking will suddenly reap the fruit of his Labour with joy."

These quotations serve a twofold purpose. In the first place, they afford an indication of the views upon the constitution of the metals which prevailed, with unimportant modifications, from the time of Jabir (*c.* 721–813) for a period of nearly a thousand years. Secondly, they illustrate the peculiar fitness of the seventeenth century mind for interpreting, and recording in the vigorous English of the day, the philosophy, the mysticism, and the superstition of the alchemists, from Jabir to Paracelsus and Glauber. Thus, Richard Russell imparts alike to the "Works of Geber," to "Beguinus his Tyrocinium," and to "the Triumphant Chariot of Antimony, with Kirkringius his Notes thereon," the same archaic flavour and picturesque charm which Lord Berners infused in the preceding century into his English version of Froissart's "cronycles of Englande, Fraunce, Spayne, Portyngale, Scotlande, Bretayne, Flaũders, and other places adioynynge."

A similar atmosphere permeates the writings of Russell's contemporary, John French, the translator of Glauber, Sendivogius and Paracelsus, and of "a Chymicall Dictionary explaining hard places and words met withall in the writings of Paracelsus, and other obscure authors." "Are not Philosophers," asks French in his introduction to Glauber's "Description of new Philosophical Furnaces," published in 1651, "the best moralised men, of the purest lives, and most serviceable in their generation? It shall be my practise as long as I

live to be instrumental in promoting true knowledge, whether by way of Translation or any other way of making what is occult manifest."

Boyle's "Sceptical Chymist" (1661) marked alike the decline of alchemy and the gradual abandonment of Latin by exponents of the new chemistry which was to arise. Nevertheless, Walter Harris and others continued the tradition of the seventeenth century translators; and no true "Lover of Chymistry" would willingly forgo such passages as Boyle's own quotation of the experience of the Dutch sailors at Nova Zembla with a barrel of frozen beer in the winter of 1596, and Harris's description, in his Englished version of Lemery's "Cours de Chymie," of the rectification of spirits of wine, to which end, he says, "Artists have invented a long Machine, which they call the Serpent, by reason of the circumvolutions which it makes."

Dr. Holmyard has earned the gratitude of the present generation of "chymicall Artists" by placing such rare classical works as Russell's "Geber" and Norton's "Ordinall" within their reach. May we not persuade him to complete the "tria prima" by preparing a new edition of Roger Bacon's "Mirror of Alchimy!"—for, in the words of John French, "it is pitty that such useful and so learned writings should be obscured from the English Nation." JOHN READ.

Homing among Animals

How Animals Find their Way About: a Study of Distant Orientation and Place-Recognition. By Prof. Étienne Rabaud. Translated by I. H. Myers. (International Library of Psychology, Philosophy and Scientific Method.) Pp. ix + 142. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1928.) 7*s*. 6*d*. net.

DURING the present century the solution of the problem of 'homing,' or orientation from a distance, has come within sight, for backboneless animals at any rate; and the reason for the progress is to be found in the resolute use of experiment. For bees and wasps it seems quite certain that they cannot find their way home unless they have had some experience of the locality, and unless hey can see well during their return flight. Bees liberated on a lake near the hive do not return, unless by chance, for there are no landmarks to guide them. The cues utilised by bees and wasps are visual; by following these they retrace the path they travelled in leaving the hive or nest. But there is evidence that the cues are relations between objects rather than the objects themselves. There seems to be a co-ordination of clues into what might be called a synthetic impression—what would be in our case a mental picture; and there may be a successful bee-line for the hive though various intermediate cues disappear.

After many journeys the insect becomes more confident; it is even probable that muscular memory may be substituted for visual cues over a large part of the course. When the bee is near the hive, olfactory, tactile, and perhaps other cues come into play. But, according to Rabaud, the homing of flying Hymenoptera depends mainly on visual cues, and it is quite unnecessary to postulate any special sense of direction. The experiments referred to convince one that this must be on the whole a sound conclusion.

In the pedestrian ants the cues are more heterogeneous. Olfactory hints are most important for those that travel in columns. Visual cues intervene when the trail is accidentally destroyed.

"As for isolated ants, they follow simultaneously visual cues of various kinds—light and large objects—closely associated, and connected in addition with features of the ground, notably with the slope. Every cue is associated with all the others and also with the topographical position of the nest."

There seems to be a registration of the topography as a whole, for on the return journey the experienced ant may neglect roundabout paths and take short-cuts. In the course of time the return perhaps becomes a matter of kinæsthesis and appreciation of distance. But, as in the case of bees, there is no warrant for postulating any special sense of direction.

Among the blind termites a trail is left by the troop and the cue is altogether olfactory. If the path is swept, the termites are completely disoriented. In limpets the return to the habitual position is mainly due to tactile cues. For all invertebrates that show any 'homing,' the facts can be satisfactorily interpreted in terms of visual, olfactory, tactile, and baræothetic or kinæsthetic cues.

In regard to vertebrates, the conclusions are less secure, for fewer experiments have been made. The most satisfactory data are in regard to carrier pigeons, but the case is complicated by the gradual training which the birds receive from man. They can find their way home from a distance of several hundred miles, and when they did not themselves make the particular outward journey. The evidence for a special magnetic or electromagnetic sensi-

tiveness is very dubious; the theory that the bird registers its outward journey in detail, and then retraces its steps, has to face the difficulty that the pigeons are often taken to a distance by train; Rabaud favours the view that the pigeons during their period of training acquire a considerable knowledge of places and utilise this experimentally on their return journey, even from a region not previously visited. There are, however, some alleged returns on the part of untrained carriers, but these might be fortuitous.

Against the possibility of homing without experience, it is perhaps enough to notice that in many cases the travellers from a great distance fail to return at all. In 1895 five thousand pigeons were released at sea at varied distances west of Croisic. The number of returns and the speed of the returns diminished with the distance and the altitude increased. Out of 1500 pigeons released at 500 kilometres, 300 returned within forty-eight hours—a sufficiently remarkable fact; the others were found scattered everywhere, in England, Spain, Portugal, Algeria, at Cape Verde, in Egypt, and in the Caucasus. Very significant is the fact that the return journey often takes far too long for the distance involved. Thus eight pigeons, ignorant of the particular route, were transported from Antwerp to London.

> "Released at six o'clock in the morning, in fine weather, they turned about for a long time, and then flew off and had returned to Antwerp by seven in the evening, having taken thirteen hours to accomplish a journey normally requiring barely three."

This points strongly to the conclusion that whenever there is difficulty in the return journey, because of inexperience, absence of landmarks, bad weather, darkness, or the like, there is much tentative flying on the carrier pigeon's part. The more the groping bird flies about, the greater is its chance of finding some cue.

In the well-known experiments made by Watson and Lashley on the terns nesting on the Tortugas, a percentage of birds returned from great distances, even of 800 miles, and from previously unvisited waters into which they had been transported in closed baskets on board ship. But the successful return journeys took an unnecessarily long time.

It is regrettable that the cases of homing on the part of domesticated animals, such as cats, dogs, horses, cattle, and sheep, remain at an anecdotal level. "A cat taken by rail from Fife to Ayrshire was back again in two or three days"; there are many such unprecise records, which should be tested experimentally. There would certainly be some interesting result.

Prof. Rabaud has written a useful book on an interesting problem; and though, for our part, we should not wish to hurry to a conclusion, we admit that he has made out a strong case in favour of interpreting all homing in terms of a memory or registration of sensory cues. His book is a good example of scientific scepticism and caution, and it badly punctures the hypothesis of a special sense of direction. Yet when we think of the most recent experiments on homing bees, the average success of ordinary bird migration, and such striking cases as the return of a swallow from Africa to the Aberdeenshire farm-steading where it was born the year before, the work of Watson and Lashley on terns, and the stories we have heard of homing cats, we are glad that Rabaud does not consider the question entirely solved.

J. A. T.

General Science for Schools.

(1) *General Science.* (*Mainly Chemistry and Biology.*) By Dr. E. J. Holmyard. Pp. xiii + 236. (London and Toronto: J. M. Dent and Sons, Ltd.; New York: E. P. Dutton and Co., n.d.) 4*s.*

(2) *Everyday Science: a Course of General Science related to Human Activities.* By Dr. L. M. Parsons. Pp. xi + 695. 8*s.* 6*d.* Also in parts: I, The Sky, the Earth, and Life. II, Physics: Man's Use of Motion. III, Chemistry: Man's Use of Matter. 3*s.* each. (London: Macmillan and Co., Ltd., 1929.)

(3) *Junior Science.* By C. A. Stebbins. Pp. xii + 352. (New York: The Macmillan Co., 1928.) 6*s.*

(4) *Introductory Science for Botany Students.* By K. E. Maris. Pp. vii + 181. (London: John Murray, 1928.) 3*s.*

(5) *The Romance of Reality: the Beauties and Mysteries of Modern Science.* By Dr. Beverly L. Clarke. Pp. ix + 225. (New York: The Macmillan Co., 1927.) 10*s.* net.

(1) FOR years past, teachers have been saying that in the early stages science should be taught in a general way; that historical treatment is desirable; and that the lessons should be of the object-study sort. It is to be hoped that they will like Dr. Holmyard's book, for here they have it all presented in an ideal manner. The author has excelled himself as historian and philologist, and the wine of his science teaching requires no bush. His volume is intended as a second course, between an introduction and more formal study; but it is to be

feared that it may prove rather difficult at that stage. For the sixth-form boy who wishes to link up his science with history and with classical lore, and vice versa for the history and the classical specialist, it should suit perfectly. Indeed, the science teacher himself who failed to derive pleasure from reading the pages would have to be either an exceptionally clever or an exceptionally dull person. For this reason, if for no other, the book is to be commended to his notice.

(2) Differing entirely from the foregoing in its method of treatment, the really excellent book which Dr. L. M. Parsons has written should make an equally wide appeal. It seems exactly suited to the general reader who desires a knowledge of the operations of natural phenomena or of the principles and applications of science. Primarily the book is designed for students at school, but the author has avoided any suggestion of writing down to immature minds, and the work everywhere demands intelligence and concentration from the reader. There are three parts, the first dealing with astronomy, geology and biology (including man); the second with physics; and the third with chemistry. The last section, very naturally, makes rather more difficult reading than the other two; but throughout there is a singleness of aim and a lucidity of presentation which cannot fail to secure appreciation. It may even do more and succeed in luring some of the rigid formalists among teachers from their straight and dusty paths.

(3) As in the case of the two books previously mentioned, Mr. C. A. Stebbins, though approaching the problem at a different angle, makes an attempt —and a good one—to instruct the young in natural science, through their interest in the things which surround them. Devoting more space to the biological than to the physical aspects, the ground is reached through such pursuits as gardening and poultry farming. The chapters on botanical subjects are exceptionally good, and contain useful descriptions of simple experiments on plant physiology. This book also is to be commended for consideration by those who wish to get out of the usual rut in teaching science to beginners.

(4) The intention of the author of the fourth book on our list is that it is to be studied as concurrent aid to a course in botany. Although she is right in asserting that the usual text-book of elementary science is designed either as a preliminary to more advanced study of chemistry and physics or merely as an introduction to the subject with no definite end in view, her own aim has not always been very steady. If her book is meant as an introduction to botany, much is included which might have been omitted; and on the other hand, it is not always of a sufficiently elementary character to serve as a 'first reader.' We confess to a liking for books which have no ulterior end in view; and in our childhood that liking was even stronger. It is so satisfying to feel—even if it is not true—that the book we are reading begins at the bottom and finishes at the top. All of which is not to say that there are not many good things in the present book, for there are. But the ideal school-book is one which can be read without help and gives the same sort of satisfaction as a dinner which has run through all its courses and has not stopped short at the fish.

(5) Dr. Beverly Clarke's purpose in writing differs from all those whose books have been mentioned above, for his immediate aim is, not so much to teach science as to show to those who are in outer darkness the beauties which can be revealed in the light of scientific knowledge. In treating of many diverse themes, from protozoa to relativity, he manages to avoid mathematics entirely, and so has frequently to fall back on analogy for elucidation. To the erudite this method may seem tedious and even unscientific, but doubtless it may help the unlearned, for whom he writes, to understand a little, and perhaps to marvel much.

C. L. Bryant.

Quantum Mechanics.

Materiewellen und Quantenmechanik: eine elementare Einführung auf Grund der Theorien de Broglies, Schrödingers und Heisenbergs. Von Prof. Arthur Haas. Pp. vii + 160. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1928.) 7·50 gold marks.

Wave Mechanics and the New Quantum Theory. By Prof. Arthur Haas. Translated from the German edition "Materiewellen und Quantenmechanik" by L. W. Codd. Pp. xviii + 124. (London: Constable and Co., Ltd., 1928.) 7*s.* 6*d.* net.

It is now just three and a half years since quantum mechanics came into conscious being—or rather more than five years if we should date it back to the material waves of de Broglie. The new theory has changed and expanded with such rapidity that even the bravest and most industrious writers have shrunk until now from the task of systematic exposition. Now, however, books on the new theory begin to come to hand, and in the near future we may expect them in increasing numbers.

Books which can properly be called books on quantum mechanics, or for that matter on any important new theory, are of three types: (1) Systematic expositions which adopt a single consistent point of view and attempt, however imperfectly, whether in an elementary way or with elaborate mathematics, to develop the theory from that point of view as a logical whole; (2) reprints or translations of original papers by the main authors of the new theory; (3) books of an introductory or miscellaneous character, usually of the nature of, if not actually, courses of somewhat disconnected lectures. Books of the first type are welcome in any numbers, however great. The principal difficulty at the present stage is not how to use quantum mechanics but how to talk about it most intelligibly. This is strikingly shown by the fact that many physicists, some of whom should know better, still speak of wave mechanics, matrix mechanics, and even the q-number mechanics of Dirac, as if they were three distinct theories instead of merely three different ways of trying to expound the same theory.

It is likely that it is only by repeated attempts at systematic exposition that we shall achieve intellectual contentment about the new theory. The first book of this type in point of time is Weyl's "Gruppentheorie und Quantenmechanik"—likely to remain for a long time to come a very notable example. The great abstractness of its mathematical form is its outstanding feature and probably the main source of its more permanent importance. But most of us, if we are honest with ourselves, though we may admit the importance of such abstractness, will admit, too, that we are as yet scarcely educated up to it. The other book of the first type which has already appeared—Sommerfeld's "Wellenmechanischer Ergänzungsband" to his "Atombau und Spektrallinien"—which expounds the theory systematically from the starting-point of Schrödinger's wave equation—will prove to many of more immediate practical assistance. We await with interest the many other systematic expositions of which there are rumours, confident that most of them will help to clarify our modes of thought and speech about atomic physics.

Books of the second type of course tell us nothing new. They are obviously a convenience to many students, especially in translation. We welcome for this reason the recent publication of translations of the original papers of Schrödinger and of selected papers of Brillouin and de Broglie. In spite of this convenience, however, it is questionable if there is not an element of danger to the student in the immediate publication of collected papers in book form. A book is a much more imposing thing than a few offprints, and is liable to be given an authority which its contents do not warrant. It is clear from his preface that no one is more fully alive to this danger than Schrödinger himself.

Books of the third type may obviously range in value between very wide limits. At their best they have very much of the nature of books of the second type, with the added advantage that the material has been worked through by another mind. Birtwistle's "New Quantum Mechanics" is a book of this type, giving a convenient and faithful but uncritical reproduction of much of the earlier work on the theory. Another better example is Haas's "Wave Mechanics and the New Quantum Theory," which in the original and in translation is the occasion for this essay. This book is definitely not a systematic account of the new theory; it is fairly elementary—would that it were systematic too! But it does give an excellent account of various disconnected aspects and applications. The translation seems to be well done; there are one or two obscurities due to failure to use the accepted English equivalent for a technical mathematical term, but they are not serious, and slips and misprints are very few. It is likely to prove quite a useful book. R. H. F.

Bushmen of the Central Kalahari.

The Naron: a Bushman Tribe of the Central Kalahari. By D. F. Bleek. (University of Cape Town: Publications of the School of African Life and Language.) Pp. ix + 67. (Cambridge: At the University Press, 1928.) 6*s*. net.

ALTHOUGH the School of African Life and Language has been established in South Africa for a few years only, it has already accomplished much useful work in research. It has now turned to publication. It is appropriate that the first of a projected series of studies of South African tribes should be written by Miss Bleek, for, herself a distinguished authority, she worthily carries on the tradition of a name which will always be associated with the study of South African philology and ethnology. Miss Bleek's book, apart from its intrinsic interest, is noteworthy in that it embodies material of a report of an investigation which was undertaken at the request of the Government. It is gratifying to note this official recognition of the fact that these tribes present a problem which is worthy of scientific study.

Miss Bleek classifies the Bushmen of the Kalahari

into northern, central, and southern. The Naron constitute the central group. In structure and in the roots of the vocabulary their language shows affinities with the Nama tongue, but Miss Bleek considers that the differences are sufficient to warrant regarding them as two languages of one group, rather than as two dialects of one language. This is not the only respect in which they show Hottentot influence. It appears in their culture, in their religious belief, and in their physique. Certain elements in culture and physique also show Bantu influence. An obvious instance of the former is the custom of throwing the bones or dice as a method of divination in common use, but on a more elaborate system, among Bantu peoples of South and South Central Africa as a method of divination and witch-finding. It is evidently an importation among the Naron, for Miss Bleek says they seem to know very little about it.

The religious beliefs of the Naron are confused and evidently composite. Hottentot belief is clearly responsible for their hazy views of a supreme being, and Miss Bleek is more than probably correct in thinking that the original form of their religion was worship of the moon, which, by the way, as so often is regarded as masculine. The medicine man, who is both magician and doctor, holds no special position. Quarrels among medicine men lead to the use of 'grass arrows,' imitation arrows four or five inches long. These, when thrown blunt end foremost, against the opponent's karos, cause death by magic.

Miss Bleek's record is one of change, of disintegration, rather than degeneration, thanks perhaps to the fact that they have no intoxicating liquors, not even Kaffir beer. They no longer have chiefs, though the older men remember them. Originally nomad hunters, the game laws are forcing them to become vegetarians; though they retain their nomadic habits of wandering from water-hole to water-hole in small groups. For they do not cultivate, and have no cattle. Marriage was by capture, of which only a vestige remains. The only regulation appears to be that brother and sister may not marry, and polygamy is permissible, though not general. Of their mentality, Miss Bleek speaks favourably, also of their capacity for work. It is clear that their extinction is by no means inevitable, given patient training, and a sympathetic understanding of their inability to endure long uninterrupted periods of employment, which would make it possible for them to supplement their present mode of subsistence, bound sooner or later to prove inadequate.

The School of African Life and Language is to be congratulated on its first publication. Such an excellent beginning should encourage some generous benefactor to supplement the funds, which are at present inadequate to meet the cost of publication on a more extensive scale.

Heat for Students.

Heat and Thermodynamics. By Dr. J. K. Roberts. Pp. xvi + 454. (The Student's Physics, Vol. 4.) (London, Glasgow and Bombay: Blackie and Son, Ltd., 1928.) 30*s.* net.

An advanced text-book upon heat has been urgently needed. Most of the literature available for honours students which dealt with the wide range of topics that are included under this title has either been too elementary or too specialised, and, in particular, it has been impossible to refer them to any good account in English of the many accurate experimental researches of recent years; whilst it is admittedly important that they should consult original papers occasionally, the pressure of preparation for examinations does not permit of extensive reading of this nature. Dr. Roberts's book fills the gap in a student's library that was present as a result of this state of affairs, and provides in a single volume a reasonably complete account of both the theoretical and experimental aspects of the subject.

The first eleven chapters are mainly concerned with thermal measurements and such theoretical matters as are directly connected with them. Thermometry, the properties of gases, calorimetry, thermal expansion, and the transfer of heat are dealt with more or less in the usual order, but with a range and detail that is new, and makes excellent reading. Considerations of space have made it necessary to omit details of some important and accurate experiments that would find a place in a larger treatise, but Dr. Roberts's choice of typical experiments of each class, based as it is upon his own experience at Teddington and elsewhere, is that of an expert. It is satisfactory to find in this connexion that whilst most weight has naturally been given to recent work in which high precision was the objective, the classical researches of Andrews, Regnault, Rowland, and others have not been entirely ignored. The work of Laby and Hercus on the mechanical equivalent of heat appeared too late for description in full, but the methods and results have been given in outline. The only important alteration that might be desired in these earlier chapters, in fact, is the pro-

vision of even fuller accounts than have been given of the properties of bodies at very low temperatures, and the ways in which they have been studied; the relevant original publications are scattered, and those emanating from Leyden, in particular, are not to be found in all science libraries.

The remainder of the book is devoted to the more theoretical aspects of heat, thermodynamics being represented by seven chapters, and radiation and quantum theory by three. The thermodynamics has been developed from the two fundamental laws, without recourse to the methods of statistical mechanics. Certain sections are not given so fully as in Preston's "Theory of Heat," which could scarcely be improved upon for its treatment of general principles, but Dr. Roberts has succeeded in presenting thermodynamics as a useful physical tool, and not as a mere branch of mathematics, more than fifty pages, for example, having been alloted to physical and chemical equilibrium and to the Nernst theorem.

The section on the classical theory of radiation, again, is not developed with the rigour of M. Planck's "Wärmestrahlung," the conception of rays being made more use of than that of cones of radiation, but there are complete proofs of the laws of Kirchhoff, Stefan, and Wien, the last being obtained by the help of Westphal's geometrical simplifications. A derivation is also given of the formula for the number of independent vibrations of a continuous medium, whilst there is a chapter on power cycles, and one on the equation of state of solids, the latter being a good introduction to the work of Born, Debye, and Lennard-Jones in this field. An appendix includes a short but useful list of thermodynamic relations, and a few pages on the properties of steam.

It must be emphasised that this is essentially a text-book, and that it is not intended for specialists. It should, nevertheless, interest many who have left the days of examinations far behind them, and its value for these readers will be enhanced by the numerous foot-note references to original papers. With regard to its chief aim, it is very difficult to predict with any certainty whether or not any text-book will appeal to students. The writer has, however, already brought it to the notice of his classes, and so far as can be judged from the short time during which it has been in use, it fulfils its purpose admirably; there is every indication that Dr. Roberts will have to be congratulated on having produced a book that can be recommended for examination purposes without an alternative.

K. G. E.

British Ferro-Concrete Bridges.

Reinforced Concrete Bridges: the Practical Design of Modern Reinforced Concrete Bridges, including Notes on Temperature and Shrinkage Effects. By W. L. Scott, assisted by C. W. J. Spicer. Second edition, enlarged. Pp. xii + 220 + 26 plates. (London: Crosby Lockwood and Son, 1928.) 25*s.* net.

DURING the past decade a very great extension in the use and art of reinforced concrete construction has taken place. Particularly is this the case in connexion with bridges; and the considerable number of important bridge structures of ferro-concrete erected in Great Britain within recent years is significant of the activity of development. Generally speaking, the employment of such forms was noticeable at an earlier date both in America and on the Continent, and the foreign literature on the subject is fairly extensive. But the book before us probably represents the only volume published in Britain wholly devoted to the exposition of bridge design and construction in reinforced concrete. As such it is both necessary and welcome.

Reinforced concrete design developed along rather crude empirical lines at first, and under such conditions bridge construction in this material was somewhat tentative and not free from fears as to reliability. Paradoxically, the destruction of bridges during the War provides the best proof of the inherent powers of resistance of this class of construction when well designed and soundly built, the difficulty of completely destroying them having been well demonstrated. In first cost, probably the reinforced concrete bridge does not offer any great advantage over the steel structure, but in upkeep charges it is superior. The present volume does not deal with costs, but it displays considerable power in the art of straightforward exposition of forms and design methods and it covers the range of suitable concrete bridge types very clearly.

After chapters on rolling loads and influence lines, wind pressure and temperature effects, etc., which may be considered preliminary to the main theme, the author proceeds to discuss arch bridges and the elements of their design in detail. The ferro-concrete type lends itself to the arch form of construction most appropriately, and has, indeed, been the chief cause of a considerable development in the theoretical bases of rigid arch design. The book deals with both hinged and hingeless arches, but in the main the details of analysis are limited to the parabolic forms of these. The author presumably considers the development adequate to cover the variations therefrom.

A clear chapter is given on girder bridges and includes consideration of both the parapet girder and the deck slab and beam types. This is followed by a short chapter on the bowstring girder, which, as it has developed in reinforced concrete work, becomes a variant of the arch type, in which is incorporated a horizontal member suspended directly from the rib. The weakness, in reinforced concrete, of the diagonal shear members common in steel girders, is explained.

The remaining part of the book discusses temporary and permanent hinge construction and deals with the problems of foundations and abutments. The last chapter gives brief explanatory descriptions of several characteristic and important constructions. This includes an outline of the difficult and unique Oswald Street Bridge at Glasgow; but does not refer to the Royal Tweed Bridge at Berwick, the main span of which is the largest reinforced concrete span yet erected in Great Britain. There is an appendix dealing with specifications and materials. The diagrams throughout the book are noticeable for simplicity and clearness; while the many excellent photographs of bridges throughout the text and in the last chapter convey a very clear impression of the artistic effects achieved in modern reinforced concrete bridge design.

A New Spider Book.

The Biology of Spiders. By Theodore H. Savory. (A Series of Biological Handbooks.) Pp. xx + 376 + 16 plates. (London: Sidgwick and Jackson, Ltd., 1928.) 16*s.* net.

MR. SAVORY has performed a useful task in collecting together into one volume the main facts of the biology of spiders. The ideal suggested in the preface, that the reader should have no need to look elsewhere for further information on the subject, was, of course, a counsel of perfection, but for most purposes the account is adequate. The student intending to embark on research—on eye structure, for example—will certainly not be content with the sketch here presented, but he will be greatly helped by an excellent bibliography, very conveniently arranged under appropriate headings.

About the section on external and internal structure little need be said. Mr. Savory is a competent zoologist in addition to being a very keen student of spiders, and his summary of morphological facts may be trusted, and will be found sufficiently complete. The illustrative figures are diagrammatic but generally to the point, though we are rather surprised that he should have passed Fig. 37 (p. 54); this is decidedly misleading as regards the œsophagus, which would appear to have no communication with the outside world. We turn with more interest to the subsequent bionomic sections, which the author justly claims to contain certain original contributions to what would otherwise be a mere compilation—useful though such a compilation might very well be.

The chapter on behaviour is interesting, and we commend the author's insistence at the outset on a cautious interpretation of the phenomena observed. The commonest mistake of naturalists is the attribution to the creatures they study of mental powers which they are far from possessing, and we are inclined to agree with Mr. Savory when, on a later page, he suggests that even such practised observers as Bristowe and Locket have somewhat erred in this respect in their interpretation of the phenomena presented by mating spiders.

The chapter on the spider's web is brief, and is chiefly interesting for the author's views on the origin and evolution of the more complicated snares. These views are of course speculative, but they are at all events reasonable. Naturally he starts from what he calls "the drag-line habit," which would necessarily result in the coating of the retreat. The spread of this coating to the immediate neighbourhood would give the sheet-web of *Tegenaria*, which Mr. Savory regards as the primitive type of snare, and the other forms appear to him to have arisen from the need to economise in silk.

Mr. Savory's account of protective coloration and mimicry gives, in a small space, all the important facts, and his acquaintance with current literature is shown by the inclusion of the interesting experiments of Gabritschevsky on changes of colour exhibited by *Misumena vatia*, published in 1927.

In dealing with mating habits, Mr. Savory of course alludes to the classic researches of the Peckhams on the antics of amorous jumping spiders, but he is chiefly concerned with the more recent observations of Gerhardt, Bristowe and Locket on other araneid families. We regard his discussion of these phenomena as among the most interesting and valuable portions of the work.

After reviewing the fossil spiders and the trapdoor spiders, the author proceeds to consider the probable course of evolution of the whole order. He figures a hypothetical primitive spider and suggests lines of development resulting in the main divisions now recognised. A full discussion of his views would occupy more space than is at our dis-

posal. Sufficient has been said to give a fair idea of the scope of the whole work.

Mr. Savory's style is clear, if his touch is not conspicuously light. We rather regret his revival of the term 'spiderling' which used to irritate us in McCook, and we now and then find him employing an uncouth term. What, for example, are 'Behaviourists'? The appendix on "Some other Arachnida" will be welcomed by certain of his readers, but we hope that when a new edition is called for, he will supply better figures to illustrate the ticks. Those in the text are, not to put too fine a point upon it, atrocious. C. W.

Birds of Malaya.

The Birds of the Malay Peninsula: a General Account of the Birds inhabiting the Region from the Isthmus of Kra to Singapore with the Adjacent Islands. By Herbert C. Robinson. (Issued by Authority of the Federated Malay States Government.) Vol. 2: *The Birds of the Hill Stations.* Pp. xii + 310 + 25 plates. (London: H. F. and G. Witherby, 1928.) 35*s.* net.

MR. ROBINSON has produced his second volume on the birds of the Malay Peninsula with commendable speed, only one year having elapsed since the publication of the first volume, which contained the "Common Birds of the Malay Peninsula." The present contains descriptions of the "Birds of the Hill Stations," Mr. Robinson having fixed a minimum level of 2500 feet for the purposes of his work.

The title of the volume is perhaps a misnomer, for hill stations in the Malay States are still in their infancy, and the volume might have been called with greater accuracy "Birds of the Hill Ranges." The height of the majority of the main hill-ranges runs to some 7500 feet and, for the most part, they are covered with primitive forest but little cut up by villages and their cultivation, though intersected here and there by grassland and forest streams.

In reviewing the first volume we have already expressed our regret that the author has been obliged to bring out his volumes in the form adopted. The work has been divided into four parts. In the first volume, as already mentioned, he dealt with the "Common Birds of the Malay Peninsula," whilst the two volumes still to come will include "Shore and Water Birds," the "Rarer Birds," etc. Such a method of dealing with the avifauna of any country must necessitate an immense amount of unnecessary overlapping, which makes it very difficult for the would-be reader and student to find his way about in the different volumes. In a vast area such as the Malay Peninsula, birds which are of great rarity in one part are common elsewhere, whilst many are restricted in their habitat to comparatively small areas and are absent elsewhere.

In spite of this one great drawback, the present volume forms a most valuable, interesting, and well-written addition to our knowledge of the avifauna of the Malay Peninsula, and we congratulate its author on its production, which will fill a long-felt want. The classification adopted is on the same lines as that for the past volume. It commences with the game birds, continues with the pigeons, rails, raptores, and owls, and concludes with the Pico-Passeres. The author ignores orders and suborders and adopts the easier, and perhaps wiser, course of dividing his birds into families only. On the other hand, he accepts a vast number of genera which are based on very slight characteristics. Thus he resuscitates Hume's name *Athenoptera* for some of the Scops owls of the *spilocephalus* group, though these birds are almost indistinguishable from some members included by him in *Otus*. In the circumstances it is perhaps discreet of the author not to attempt to explain to his readers the characters upon which he relies to distinguish his genera. The 25 coloured plates by Gronvold are of their usual excellence and of a standard worthy of so important a work; the paper used for the text, however, is very heavy, and the large volume therefore somewhat inconvenient to handle.

We are glad to see that Mr. Robinson gives vernacular names to the great majority of forms with which he deals. Many authors omit this important detail on the grounds that trivial names given by Orientals are of no value, as they refer only to classes and not to species of birds. Most of them forget that these class names are nearly always amplified by prefixes descriptive of the particular species described.

We shall look forward with pleasure to Mr. Robinson's future volumes, which we feel sure will be of equal value to the present.

Physics for Non-Specialist Students.

Physics for College Students: an Introduction to the Study of the Physical Sciences. By Prof. A. A. Knowlton. Pp. xix + 641. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1928.) 18*s.* 9*d.* net.

PROF. KNOWLTON'S text-book is an attempt to treat the subject matter of physics in such a way as to justify its study by students who do not

need it for future technical work but simply for its general educational value. Having taught physics for twelve years in an engineering college where it required no justification, the author moved to an arts college and was then faced with the question: Why should students study physics? This book is an outcome of his attempts to present the efforts of man to systematise and master his physical environment, in such a way that the question is satisfactorily answered. In order to do this, he has had, inevitably, to drop the usual more or less logical presentation of physics under separate headings of mechanics, heat, etc.; and further, to add the necessary spice, he has included a good deal more of the 'new physics' than is the custom in such text-books. This entails leaving out certain portions, chiefly accounts of the older classical experiments, and methods of measurement, the latter being left to the laboratory course: the book is thus kept a reasonable size; there are fifty chapters, each meant to be read comfortably at one sitting.

The first chapter explains the place of physical science in modern civilisation and gives an excellent account of scientific method and attitude of mind and the distinction between facts and hypotheses. Starting from the notion of 'work,' since "work is the most general and important article of commerce in the modern world," the author leads up to the concept of 'energy,' which is the central theme of the book. This accounts for the early introduction of chapters on the measurement of energy in its various forms and on the connexion between matter and energy. In the thirteenth chapter the sun is considered, as an introduction to the study of the sources and modes of distribution of energy, and this leads to the treatment of the motion of falling bodies, the production of motion, spectra, magnetic and electric fields, and atomic structure. Then after wave motion comes radiation, leading up to X-rays, relativity, and quantum theory. The remaining fourteen chapters deal with the physics of the air, including sound; properties of matter, solid and fluid; some simple thermodynamics; and, finally, some more advanced magnetism and electricity with their practical applications.

The obvious advantages of this method of presenting a subject like physics are that it enables students, after the first few chapters, to have a mental background against which further knowledge can be viewed, and it also allows what Prof. Knowlton calls a cyclic arrangement, that is, a constant reiteration of fundamental facts and principles. The attempt made throughout to utilise, in explanation, things familiar in everyday life is specially noticeable in the list of examples which follow each chapter, which are graded as to difficulty. In fact, some of the problems are so attractive as to be almost irresistible, which is saying a good deal. There are also timely paragraphs on scientific accuracy, measurement of quantities which vary irregularly, physical 'laws,' etc.; and nowhere has true scientific caution been sacrificed to enthusiastic stimulation of interest. The illustrations are good, especially the photographs in the optical section.

Prof. Knowlton has certainly succeeded in producing a text-book which justifies its own study; and it is with no surprise that one learns that it has already met with "marked student approval."

Zoology for Indian Students.

An Elementary Text-Book of Zoology for Indian Students. Adapted from "An Elementary Course of Practical Zoology," by Profs. T. J. Parker and W. N. Parker. Second edition. By B. L. Bhatia. Pp. xii + 684. (London: Macmillan and Co., Ltd., 1928.) 15*s*. net.

SOME nine years ago the excellent "Elementary Course of Practical Zoology," by T. J. and W. N. Parker, was taken in hand by Mr. B. L. Bhatia, of the Government College, Lahore, and adapted to the special needs of Indian students. The book in its new form, entitled "An Elementary Text-Book of Zoology for Indian Students," has now deservedly reached a second edition. While the plan follows in general that of the Parkers' original book, it has been modified so as to make it less of a mere description of 'types' and more of a general text-book.

Part I., occupying about a third of the volume, remains as before—a description of the frog, forming an admirable introduction to vertebrate anatomy, histology, and physiology. There are various improvements in detail, as, for example, in the figure of the frog's heart, which is still capable of improvement, as is also the account of the physiological action of the conus arteriosus.

Part II. shows more alteration. A good account of the malarial parasite is given; the student is told how the mosquito "not only sucks blood but also spits into the wound," and his attention is further gripped by his being made to realise how India was the scene of Ross's original discoveries, and how practically important to India is the successful prevention of malarial disease.

In the list of special types, various changes have been made to suit Indian conditions. The earthworm is no longer the familiar *Lumbricus*, but the

Indian *Pheretima posthuma*, which, while in many respects equally suitable, suffers under the great disadvantage from the teacher's point of view that its nephridial organs are of extreme complexity and accordingly much less suitable than those of *Lumbricus* for driving home certain of the important general principles of the morphology and physiology of renal organs. The crayfish of the Parkers' book is replaced by the prawn *Palæmon*, so far as external features are concerned, and the cockroach ; while, as is entirely suitable, a short sketch is given of the life-history of a mosquito. The freshwater mussel as a type has been cut out, while on the other hand there have been added to the book chapters dealing with more general aspects of zoology. The main groups of the animal kingdom are briefly reviewed, and the volume concludes with three chapters dealing with cytology, embryology, and evolution.

Here and there are details which should be looked into when the next edition is being prepared—such as the references to 'true bone,' air-bladder, and conus arteriosus of fish ; and the absence of nephrostomes in the metanephros. In the chapter on evolution there is still apparent the tendency to think in terms of organs or parts of organs instead of in terms of individual animals ; while many teachers would regard it as an improvement to drop entirely the terms 'acquired character' and 'mutation'—the first because its use seems at once to cause confusion of thought in certain minds, the second because its use by different writers in different senses has caused it to lose its value as a precise scientific term.

Apart from such minor blemishes in detail, the book is a thoroughly good one and may be warmly recommended to Indian teachers and students of zoology. It is well illustrated, and the descriptions of the various animal types are accompanied by excellent directions for their practical investigation by the student.

A Bibliography of Bibliographies.

Bibliography—Practical, Enumerative, Historical: an Introductory Manual. By Henry Bartlett Van Hoesen, with the collaboration of Frank Keller Walter. Pp. xv + 519. (New York and London: Charles Scribner's Sons, 1928.) 27*s.* 6*d.* net.

THIS work is based upon a series of lectures delivered annually at Princeton University since 1923. Its principal object is to train the graduate student in the use of bibliographies, and to inculcate the value of method in his practice. The backbone of the work is a bibliographical appendix covering some eighty pages and enumerating more than two thousand bibliographies, and the first eleven chapters of this work are in the nature of a commentary upon the bibliographies listed.

The authors rightly stress the fact that their manual is introductory rather than complete, and that their aim has been to set the student's feet on the right path of investigation rather than to load him with descriptions of all necessary material. Within these limits we consider that the work has been carried out successfully. The selection of bibliographies is judicious and singularly free from national bias, and the critical commentary proves that the authors are skilled craftsmen. Omissions, of course, there are. Archive searching should have been given a separate chapter, and the "Official Guide to the Public Record Office of Great Britain" should have been included. Under 'technology,' again, we find an entry for the "Catalogue of the German Patent Office," but none for that of the British Patent Office, or for its numerous "Guides" and "Subject Lists." A more serious defect is the weakness of Chapter ii. on practical bibliography. The nature of research is insufficiently explained, and the collection of bibliographical material and the rules for compiling bibliographies are treated together although the two subjects are entirely distinct. Most collectors err on the side of false economy and pay for it in after life by having to recopy or remount their collections on paper of larger size. The modern 'ringbooks' appear to offer one satisfactory solution of the problem.

Again, the student should be warned against undertaking work for which he lacks the necessary technical equipment. An engineering subject demands an engineering training. Jenkins's "Power Locomotion on the Highway," 1896, and Hopwood's "Living Pictures," 1899, are fair examples of successful bibliographical work by competent men. The bibliographer should also be advised that, in whatever order he elects to publish his bibliography, he should at some period of its compilation sort his entries in chronological order and submit them afresh to critical examination ; for chronological order solves many questions of authorship, priority of statement, and other bibliographical problems. We think that in this chapter the authors have leaned too heavily upon outside opinions, which are often contradictory and far from helpful.

The final chapters of this work are careful compilations of the histories of writing, printing, and book production. They form interesting reading, but add little to the practical value of the work.

Our Bookshelf.

Archæology.

Oraon Religion and Customs. By Rai Bahadur Sarat Chandra Roy. Pp. xv + 418 + 20 plates. (Ranchi: *Man in India* Office, 1928.) 12 rupees.

ETHNOLOGISTS are indebted to Sarat Chandra Roy for his valuable book "The Oraons of Chota Nagpur" (1915), and now he has provided a study of Oraon religion and customs which should be read by all those who are interested in primitive religions. The Oraons (or Kurukhs) are immigrants on to the plateau which they share with the aboriginal Mundas and other tribes.

The especial value of this book is not merely in the detailed accounts of socio-religious and religious rites and ceremonies and magical practices, but in the very suggestive religious transformations that have occurred since the Oraons arrived, and the process is still continuing. The original religion centred round (1) the supreme spirit, or spirit of good, Dharmes, who was formerly the sun-lord, the author, preserver, controller, and punisher of men, gods, and spirits, and (2) the 'evil-eye' and 'evil-mouth' as representing the spirit of evil. Most of the village gods and spirits were appropriately borrowed from the Mundas, who had long been settled on the land, and a few have been borrowed from their Hindu neighbours. There are also ancestor-spirits whom the deceased Oraon joins on the annual 'great marriage' or 'bone-drowning' day; apparently these were formerly considered to be mischievous, but now are mainly beneficent. The most important annual ceremony is the spring festival of the 'marriage' of the village priest with his wife, in token of the marriage of the sun god with the earth goddess, so that the earth may fructify; probably it is a survival of a festival of the food-gathering stage in their history. The licentiousness permitted on this occasion is believed to stimulate the fertility of the earth.

The germ of the Bhakti cults was very ancient, but under Hindu influence it was fructified as reverent faith in and loving adoration of a personal deity; thus was the way prepared for Christianity, which was introduced in 1845. Hindu organisations have tried to bring the Oraons into the official Hindu fold by giving them ceremonial purification, but with little effect.

Chivalry: a Series of Studies to illustrate its Historical Significance and Civilising Influence. By Members of King's College, London. Edited by Prof. Edgar Prestage. (The History of Civilisation Series.) Pp. xv + 231 + 24 plates. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, 1928.) 15*s*. net.

A VOLUME composed of a series of lectures delivered by a number of individuals must necessarily lack the unity of outlook of a book by a single author. This is a serious defect in dealing with so important a factor in the history of western civilisation as chivalry. However great an authority each of the authors whose lectures are included here may be on his special branch of the subject, the description of the characteristics of chivalry of countries—England, France, Spain, Portugal, and so on—misses the interpretation of the facts which is the function of a history of culture such as this series aims to be. Hence apparent discrepancies in the attribution of chivalry as a characteristic outcome of the temperament of now one, now another, nation.

A broader treatment would have brought out the fact that chivalry was an expression of the ideals, temperament, and culture of the Nordic peoples who had imposed themselves as rulers over a great part of Europe. Hence the paradox of chivalry that its ideals prevailed within the caste only, and did not affect relations with the community, who, in fact, were a subject population. Subject to this reservation, this book is an addition to the literature of chivalry which is to be valued, especially where it breaks new ground. The illustrations, as nearly as possible contemporary, have been particularly well selected.

The Ancient Wells, Springs, and Holy Wells of Gloucestershire: their Legends, History, and Topography. By R. C. Skyring Walters. Pp. xiv + 194 + 62 plates. (Bristol: The St. Stephen's Press, 1928.) 12*s*. 6*d*.

GLOUCESTERSHIRE, owing to its geological formation, is a county exceptionally rich in springs and wells. The remote character of much of its countryside has tended to preserve the memory of the sacred character attributed to water by early man, which in modern times survives in the association of the well with a Christian saint. In his descriptive account of the numerous sacred wells of Gloucestershire, Mr. Walters, while constantly recognising that paganism lies at the root of the esteem in which the wells have been held, does not as a rule offer any suggestion as to the origin of the specific cults, or trace it further back than the dedicatory saint. The custom of offering pins, rags, and coins to the well he attributes to the Romans; but the distribution of the custom in Great Britain and its prevalence in Ireland point to a more remote origin. Mr. Walters admits Wandswell as "at least one survival of paganism," the name being connected with Woden, but to speak of "Christian well-worship" is a contradiction in terms unless Christian is used merely in a chronological sense.

The Vampire: his Kith and Kin. By Montague Summers. Pp. xv + 356 + 8 plates. (London: Kegan Paul and Co., Ltd., 1928.) 15*s*. net.

LIKE his books on witchcraft, Dr. Summers' study of the vampire combines a vast erudition with a complete acceptance of the orthodox theological point of view. Some knowledge of the history of

controversy relating to witchcraft and demonology is requisite in order that the reader may not dismiss the book as merely credulous and not, as it is, a real contribution to the literature of the subject. Yet it may not be uninstructive to mention one minor matter which brings out clearly the author's point of view. He accepts the real existence of the vampire. That is a matter of authority. He doubts that a nurse was in attendance when Bram Stoker's play "Dracula" was presented in London. Yet this was a statement of fact and could have been verified by inquiry. If, however, the reader is prepared not to exact a scientific spirit of scepticism, Dr. Summers' book will be found a mine of information relating not only to the vampire belief, but also to the abnormal pathological states which, without doubt, gave rise to the belief—a gruesome but nevertheless instructive field of inquiry.

Biology.

Faune de France. 18 : *Diptères* (*Nématocères*) ; *Chironomidæ*, III. *Chironomariæ.* Par M. Gœtghebuer. Pp. 174. 32 francs. 19 : *Hyménoptères vespiformes*, II. (*Eumenidæ, Vespidæ, Masaridæ, Bethylidæ, Dryinidæ, Embolemidæ.*) Par L. Berland. Pp. viii + 208. (Fédération française des Sociétés de Sciences naturelles : Office central de Faunistique.) (Paris : Paul Lechevalier, 1928.) 36 francs.

THE "Faune de France" series of monographs is now familiar to most zoologists and the separate parts already issued have been noticed at intervals in our columns. The two most recent fascicules that have come to hand form Nos. 18 and 19 in that series ; No. 18, by M. M. Gœtghebuer, is concerned with midges forming the tribe Chironomariæ of the family Chironomidæ; and No. 19, by M. L. Berland, deals with the true wasps, together with certain related groups commonly united to form the family Bethylidæ. The method of arrangement adopted in these two parts is similar to their predecessors ; namely, a short introduction on structure and biology followed by generic keys : under each genus is a key to the species, while each species is separately described, its general distribution indicated, and any important facts known relative to its biology are recorded. The numerous illustrations and full bibliographic references are also noteworthy. We commend these two monographs to the notice of English entomologists, since the French fauna includes most of the British species in the groups concerned. A. D. I.

Gilbert White : Pioneer, Poet, and Stylist. By Walter Johnson. Pp. xvi + 340 + 4 plates. (London : John Murray, 1928.) 15*s.* net.

MANY commentaries on the writings of Gilbert White have been published, but none has worked out in such detail the aspects seized upon in this volume. In analysing the matter and the method of presentation of White's observations, the author has naturally lost the very essence of the attractiveness of the original works, but he has made a scientific appreciation which will be valued by those who would understand the place of these observations in the light of modern knowledge.

The disconnected studies of "Selborne" and other works are here grouped and classified in their due relationship, ecology, birds, other vertebrates, insects, botany, geology, meteorology, and the like, and there are excellent chapters on the man, the scope of his work, and the distinctive quality of his prose style. Throughout the work the reader is brought in close touch with the meticulous observation, glimpses of far-seeing speculation, simple and clean-cut phraseology, which have made "Selborne" the most widely read of Nature books. The author claims that all the information of scientific value not previously printed from White's MS. has now been transcribed and made public in this volume.

Organographie der Pflanzen : insbesondere der Archegoniaten und Samenpflanzen. Von Prof. Dr. K. von Goebel. Teil 1 : *Allgemeine Organographie.* Dritte, umgearbeitete Auflage. Pp. ix + 642. (Jena : Gustav Fischer, 1928.) 30 gold marks.

THIS new edition of the general section of a well-known text-book has increased considerably in size, and the new material has not been simply interpolated, but the balance of the book has gradually changed with the maturing views of its veteran author as whole sections have been rewritten and reduced or increased in prominence. The tendency seems still to be towards a stressing of the inter-relationship of environment and organism during development. This side of organ development receives much attention in the general introduction, and is the special subject of the last ninety pages. The book remains an invaluable mine of information, especially upon experimental morphology. The illustrations in the new edition have increased in number from 459 to 621, most of them the work of the author, his colleagues and students.

Chemistry.

Symbols and Formulæ in Chemistry : an Historical Study. By Prof. R. M. Caven and Dr. J. A. Cranston. (Manuals of Pure and Applied Chemistry). Pp. ix + 220. (London, Glasgow and Bombay : Blackie and Son, Ltd., 1928.) 15*s.* net.

SYMBOLS and formulæ have been used incessantly from the early days of alchemy down to these modern times in which a radiating atom of sodium is represented by the scheme $^2S_{\frac{1}{2}} - {}^2P_{\frac{1}{2}\,\frac{3}{2}}$. The title selected by the authors therefore provides them with a convenient excuse for drilling a bore-hole through the whole of the strata in which the history of chemical theory is embedded. The samples which they have extracted are naturally not the same as if they had been concerned with the general history of chemistry, and many obscure details are brought into the light of day ; but the reader will find that the atomic and molecular theories, the earlier and later theories of molecular structure, including stereochemistry and co-ordination, fall

within the scope of the volume, as well as the modern electronic theory.

The reader has thus an opportunity of taking an unfamiliar course through familiar fields of study, and will be well repaid for doing so. It is a pity, however, that the cost of this sectional history is greater than that of a more comprehensive text-book, since many readers who would purchase the latter will be content merely to borrow the former.

T. M. L.

Fixation of Atmospheric Nitrogen. By Frank A. Ernst. (Industrial Chemical Monographs.) Pp. ix + 154. (London: Chapman and Hall, Ltd., 1928.) 12*s.* 6*d.* net.

THE author of this book points out in the preface that it is not written for the scientific specialist, but "for the teacher and student, for the business man and banker." The book deals first with the sources of nitrogen and the need for its fixation from the atmosphere, and then considers in detail the arc process, the cyanamide process, the direct synthetic ammonia process, and ammonia conversion products. The material is well presented, and is especially valuable on account of the full statistics given not only throughout the text and the chapter entitled "Statistics," but also in the tables at the end of the book. A fair bibliography is also included. The chapter dealing with "Economic Considerations" indicates clearly a number of economic problems that arise in the commercial fixation of nitrogen. At the beginning of Chapter ii. (p. 11) Bertholet is mentioned instead of Berthollet, and Sir Humphry Davy's name is spelt incorrectly. No mention is made of MacDougall and Howles, who first worked the arc process in Manchester, and whose patent (1899) preceded that of Bradley and Lovejoy (1902), on the basis of which the author (p. 12) claims that "the industrial fixation of nitrogen thus had its birth in the United States."

The Problem of Fermentation: the Facts and Hypotheses. By M. Schoen. With an Introduction by Prof. A. Fernbach. A Monograph of the Institut Pasteur, translated from the French by H. Lloyd Hind, and revised and enlarged by the Author. Pp. xii + 211. (London: Chapman and Hall, Ltd., 1928.) 21*s.* net.

THE author gives an interesting account of the present position of the problem of fermentation and traces its development from the time of Pasteur to the present day. The whole range of the subject is covered: alcoholic and lactic acid fermentation, the place of pyruvic acid and acetaldehyde in alcoholic fermentation, the function of phosphates and the effects of changing the reaction of the medium. Analogous processes in animal tissues are frequently referred to, such as the function of lactic acid in muscular contraction or in malignant growths. The references are given at the foot of each page and are also collected into a bibliography of some forty pages, which in addition serves as an index of authors' names. This is a volume for the specialist, but should be widely read also by those interested in related subjects for the light it frequently sheds on processes which bear some analogy to alcoholic fermentation itself.

The Determination of Hydrogen Ions: an Elementary Treatise on Electrode, Indicator, and Supplementary Methods, with an Indexed Bibliography on Applications. By Prof. W. Mansfield Clark. Third edition. Pp. xvi + 717. (London: Baillière, Tindall and Cox, 1928.) 30*s.* net.

PROF. CLARK's standard work on the determination of hydrogen ions is too well known to require any introduction. The third edition, recently issued, has been thoroughly revised and brought up-to-date. The author points out that the number of papers on this subject has rapidly increased in recent years, so that, in spite of revision and enlargement, the work probably covers the field less completely than the first edition. In spite of this, few except the advanced specialist will fail to find details required within its pages on the colorimetric or electrode methods of determination. The subject is treated from both the practical and theoretical points of view, and forms a very complete treatise. As the question of hydrogen ion activity enters into most biochemical problems to-day, selected portions of the book will be of value to most biochemists and physiologists, and can be studied with profit. There is an extensive bibliography and a list of definitions of common terms.

Scent and All About It: a Popular Account of the Science and Art of Perfumery. By H. Stanley Redgrove. Pp. viii + 100. (London: William Heinemann (Medical Books), Ltd., 1928.) 3*s.* 6*d.* net.

THE careful reader of Mr. Redgrove's booklet will gather many unusual items of information, such as the natural sources of ambergris, frankincense, opoponax ("a name for perfumers to conjure with"), and civet. He will notice that the civet used in Great Britain comes mainly from Abyssinia, packed in ox-horns; that the odour of Jockey Club is that of the sweet wild flowers wafted over Epsom Downs; that diphenyl oxide develops an odour of geranium leaves only in dilute solution; that labdanum, the nearest approach to ambergris in the plant world, is gathered by shepherds from the fleeces of sheep which browse on the hills of Cyprus and Crete; and that the garden musk (*Mimulus moschatus*) of the present day has lost its odour, possibly owing to the fragrant plant of our ancestors having been a 'form' which has since died out. Within its modest limits this little book amply fulfils the author's purpose of providing the general reader with a popular account of the science and art of perfumery.

J. R.

Inorganic Chemistry. Vol. 1: *Non-Metals.* By Dr. G. H. Bailey and Dr. D. R. Snellgrove. Pp. viii + 488. (London: University Tutorial Press, Ltd., 1928.) 6*s.* 6*d.*

THIS book, together with the companion volume, "Inorganic Chemistry. Vol. 2: Mainly Metals," is intended to cover the course for an intermediate

university examination, and is well produced for its price. The style is clear and interesting, but a lack of original and more inspiring illustrations does not aid its favourable comparison with some other recent text-books of similar character. The statement is made on p. 198 that the absorption of bromine vapour by iron filings produces ferrous bromide, $FeBr_2$; the compound formed is Fe_3Br_8, and is an important source of potassium bromide. The paragraph on sulphur heptoxide, S_2O_7 (p. 347), gives the impression that no further work has been carried out since Berthelot's supposed discovery in 1877.

An Introduction to the Chemistry of Plant Products. By Dr. Paul Haas and Dr. T. G. Hill. Vol. 1: *On the Nature and Significance of the Commoner Organic Compounds of Plants.* Fourth edition. Pp. xvi + 530. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1928.) 18*s.* net.

NOTWITHSTANDING the systematised courses in biochemistry which are now available in many centres, the new edition of this book will continue to subserve the authors' original aim of providing students of biology with an account of the chemistry and physiological significance of some of the more important substances occurring in the plant. It contains sections on fats, oils, and waxes, aldehydes and alcohols, carbohydrates, glucosides, tannins, pigments, nitrogen bases, the colloidal state, proteins, and enzymes; there is also an appendix on hydrogen ion concentration. It has been brought up-to-date, and although necessarily it contains a good deal of somewhat elementary matter, one may suggest that it could be read with profit by organic chemists who are wishful to view their subject from a biological outlook. J. R.

Engineering.

Foundations: the Examination and Testing of the Ground preliminary to the Construction of Works—Methods and Appliances. By William Simpson. (The Glasgow Text-books of Civil Engineering.) Pp. xviii + 256. (London: Constable and Co., Ltd., 1928.) 18*s.* net.

THIS book is the latest addition to the well-known series of civil engineering text-books produced under the general editorship of Prof. Moncur, of the Royal Technical College, Glasgow. Its scope is well indicated by the sub-title. It is wholly concerned with the study of the ground and of those methods of examination and test to be followed in the collection of essential data on which to base the design of the foundation arrangements for heavy structural work. The first chapters deal with the features of geological surveys, and, indeed, the whole book gives a very clear impression of what the author refers to as "the intimate relationship which exists between Structural Geology and Civil Engineering." The development of the subject proceeds through a very complete discussion of boring and test shaft methods under all conditions, both on land and under water. The final section provides a clear treatment of the procedure and appliances necessary for testing the bearing capacity of the ground by direct loading on open areas, and by test pile or exploratory tube methods in deep foundations.

The book throughout is concerned with the practical problems, apparatus and operations of search. There is no collection or classification of specific ground data; but the care with which the detail appliances and methods are explained, the descriptive excellence of the text and the clearness of the diagrams, combine to make the book eminently suitable for students.

Television. By Alfred Dinsdale. Second edition. Pp. xx + 180 + 33 plates. (London: Television Press, Ltd., 1928.) 5*s.* net.

IN a foreword to this little book, Dr. J. A. Fleming recommends it to those who desire an all-round view of the art of television as it exists at present, and of the problems and difficulties which still face the inventors in this novel field of adventure. We entirely agree with him. He also points out that in all inventions like the telephone, radio telegraphy, and television, there are two stages of development. First of all an idea strikes some one; then various people try to realise it in practice. The next stage is when an inventor like a Bell, a Marconi, or a Baird, makes an invention or discovers a device, sometimes very simple, which opens up a new pathway, and then progress is rapid. When the right clue is obtained, success follows, provided financial aid is forthcoming and systematic experiments are undertaken. The history of the past furnishes many similar cases.

The reader, even although his knowledge of physics is limited, will have little difficulty in understanding this book. There is a great demand by the public for anything new, for anything which contributes to the convenience of life, to entertainment, and to the dissemination of instruction and news. The physical importance of the new discoveries and inventions is considerable, and unlike many theories they are built on a sound experimental basis. The great obstacles to radio television to great distances at present are the disturbances caused by fading, Morse signals, atmospherics, and all the other causes which mutilate the broadcasting of speech and music.

A Text Book of Telegraphy: Theoretical and Practical. By A. E. Stone. Pp. vii + 455. (London: Macmillan and Co., Ltd., 1928.) 20*s.* net.

THIS book can be recommended to the student who has some previous electrotechnical knowledge. He will find that it is easy to understand. The descriptions of the apparatus and the systems in practical use can be readily grasped as only essential parts are shown in the diagrams. Special attention has rightly been given to multiplex systems and to type-printing telegraphs. Only the most modern methods are described. Alternating currents, the transmission of signals, submarine and radio telegraphy, are all touched on and the main theorems in connexion with them are given. The mathematical proofs in several

cases are novel, and to be commended. We were unable, however, to follow the proof of the self-induction of two parallel wires forming a loop (p. 82). However, the answer given is correct, which is the main thing from the practical man's point of view. The distinctions between the capacity of a condenser, the capacity of a conductor, and the capacity between two parallel wires, are not clearly explained. In proving the formula for the latter, the assumption is made that the charges can be concentrated along the inverse lines of the two cylinders. A proof of this should have been given. As a rule, the symbols have been happily chosen. On p. 47, however, Z is used to denote a current; this use we think quite inadmissible. On p. 402 it denotes impedance, a use which has international sanction.

Geography and Travel.

Antarctica: a Treatise on the Southern Continent. By J. Gordon Hayes. Pp. xv + 448 + 16 plates. (London: The Richards Press, Ltd., 1928.) 42*s*.

The knowledge of Antarctic matters has grown at so great a rate during the twentieth century, owing to the intensive scientific exploration of several areas, that a comprehensive work bringing together in one volume the results achieved cannot fail to be of value. This is part of the task that Mr. Gordon Hayes has set himself. In addition, he gives a critical estimate of the value of recent expeditions, and attempts some forecast of profitable lines of discovery. Beyond all this there are a number of appendices, a bibliography, many excellent illustrations, and a few maps.

There can be no doubt that Mr. Gordon Hayes has brought industry and enthusiasm to his task; and though he has no personal experience of polar work, he has at least the advantage of being an impartial critic of all expeditions. Yet it must be admitted that the book has several omissions and not a few inaccuracies, and falls far short of being a treatise on Antarctica. Some of his criticisms, such as of transport by man-haulage, are of value, but his strictures of the Wilkes expedition are somewhat severe, and his basis for judging the success of an expedition by the length of coast-line discovered is most unscientific. His list of casualties, which he calls the Antarctic Roll of Honour, is incomplete.

It is on the scientific side, however, as apart from the record of discovery, that the book falls far short of its author's aim. This is not surprising when it is realised from the author's list of works consulted that his material is derived mainly from the popular narratives of expeditions. These are not designed to give the scientific results. They are for popular reading. Of the many volumes of scientific reports of recent expeditions, practically the only ones mentioned are those of the *Terra Nova* and a few papers on the work of the *Endurance*. Moreover, there is almost entire omission of French and German works even of a popular nature. If Mr. Gordon Hayes does not make use of the available sources of material, he cannot claim to have written an authoritative treatise.

The People of Tibet. By Sir Charles Bell. Pp. xix + 319 + 57 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1928.) 21*s*. net.

Sir Charles Bell has written a most interesting and very well illustrated book on the mode of life and domestic customs of the Tibetans which may be accepted as authoritative. The shepherds and herdsmen are probably the purest specimens of the race. The inclement conditions, especially hail-storms, render the peasants' life a hard one. There is a great gulf between these classes and the nobility: the trading community forms a middle class, but with little power; the foreign trade is in their hands, and even the nobility have their commercial agents, for the Tibetan is a born trader. Begging is a hereditary profession, but the monks who go a-begging are on a different footing. There are few countries where women have so good a position, and they are active and shrewd in business matters. Monogamy, polygyny, and polyandry are all found in Tibet, but on the whole monogamy is more prevalent.

The daily life of the gentry is permeated with ceremonial and etiquette, and the usages of courtesy in all its branches are carefully taught to the young. Many of the troubles of travellers here and elsewhere have been due to non-observance of etiquette. Tibet does not lack land fit for cultivation, but lacks the men to till it. The population is decreasing owing to various causes, perhaps more especially to the large number that live celibate lives in monasteries instead of rearing families.

Geology and Mineralogy.

Kohlenpetrographisches Praktikum. Von Dr. Erich Stach. (Sammlung naturwissenschaftlicher Praktika, Band 14.) Pp. iv + 196. (Berlin: Gebrüder Borntraeger, 1928.) 10·80 gold marks.

During the last twenty years great progress has been made in the study of coal. Instead of treating it only as a material which on combustion gave certain products, investigators have been studying the material itself, its constituents, their mode of occurrence and association, and their probable method of origin. Coal is a rock rather than a mineral, and much of the progress that has been made has come from its examination by petrological methods. These methods have been developed independently in England, America, and Germany, and their results have been described in many widely scattered publications, consequently a brief summary of the work with a full list of references is very valuable.

The present work is probably more valuable as a survey of the field than as a practical handbook. In the preparation of coal specimens for microscopical examination there are so many technical difficulties and so many 'tricks of the trade' that it is doubtful whether anyone could be sure of success by simply following descriptions of the methods employed. But after describing methods, the author gives a brief but impartial statement of some of the results achieved, illustrated with many

excellent photographs, and followed by a bibliography of nearly 300 titles. The book can therefore be used as an introduction to the subject.

The author differs from most British coal petrologists in recognising only three chief constituents in bituminous coal. He considers that there is no fundamental difference between the clarain and vitrain of Stopes and other authors. He seems to favour the view that the characteristic bodies in Boghead coals probably represent algal colonies.

Some omissions were probably necessary in a work of this type, but we notice no reference to methods of bleaching or reducing the colour of coal sections. The work of Lilpop (Cracow, 1917) on this subject is worthy of mention.

The book should help students in the early stages of research work on coal, and we ought to have many more workers on this subject in England.

H. Hamshaw Thomas.

Bau und Bewegung der Gebirge in Nordamerika, Skandinavien, und Mitteleuropa: Forschungen in den Jahren 1924 bis 1927, ausgeführt mit Unterstützung der Notgemeinschaft der Deutschen Wissenschaft. Von Hans Cloos. (Fortschritte der Geologie und Paläontologie, herausgegeben von Prof. Dr. W. Soergel, Band 7, Heft 21.) Pp. viii + 241-327 + 6 Tafeln. (Berlin: Gebrüder Borntraeger, 1928.) 14 gold marks.

Those interested in theories of crustal drift will find much to their taste in this small work. Prof. Cloos extends his conceptions of ‘granite-tectonics’ to cover block-faulting and the like. His personal observations and remarks on the granite-tectonics of the Sierra Nevada, on block-faulting in Europe and America, and on the structure of the Western States, are of permanent value, whatever may be the fate of his deductions from them.

The theory advanced is that certain tectonics of the crust result from a world-wide northward flow of subcrustal material against obstacles. One expression of this appears in the wedge-form of the continents arising, as it were, from erosion by such a current. Again, the structure of western America is explained by a south to north Pacific stream impinging on the continental margin. Part of this stream is deflected to the north-west, part passes beneath the continent, and both give rise to correlated tectonic effects. Geologists who favour Wegener's continental drift theory would do well to compare it with these speculations of Cloos. To one not particularly attracted by either hypothesis, the continents appear to be becoming embarrassingly mobile.

The printing is excellent and the plates good, especially one showing the fault-plane of the Christiania trough.

The Nomenclature of Petrology: with References to Selected Literature. By Prof. Arthur Holmes. Second edition. Pp. v + 284. (London: Thomas Murby and Co., 1928.) 7*s*. 6*d*. net.

The second edition of Prof. Holmes's extremely useful "Nomenclature of Petrology" is chiefly notable on account of its reduction in price from 12*s*. 6*d*. to 7*s*. 6*d*. This no doubt will be welcomed by students and research workers, who will find the volume a comprehensive and handy work of reference.

While the author has made a few corrections and slight modifications, there still remain a few inaccuracies, and one still looks in vain for one or two well-established terms. During the eight years that have elapsed since the first edition, many new words have been introduced into petrological nomenclature. The author points out that these are, for the most part, of minor importance. Nevertheless, for this reason their usage is likely to be unfamiliar. It is therefore regrettable that, on the score of the expense, it has not been found possible to incorporate them in the new edition. The deficiencies of the book are trifling, however, and do not appreciably detract from its general utility.

Medicine.

The Blood-Plasma in Health and Disease. By Dr. J. W. Pickering. (Monographs on Medical and Surgical Science.) Pp. xi + 247. (London: William Heinemann (Medical Books), Ltd., 1928.) 12*s*. 6*d*. net.

The author has performed a useful service in collecting within the pages of a single volume what is known about blood-plasma as distinct from the formed elements of the blood. Much has been written about the physiology and pathology of the different blood corpuscles, but the results of work on the plasma have heretofore remained scattered and uncorrelated. In brief, this book treats of the composition of the plasma proteins and their relationship to each other, and of blood coagulation, the physiology of the process and how it can be aided or retarded, with the known pathological alterations in its mechanism.

Upwards of 900 papers are referred to, and it is probably the brief accounts of these investigators' researches following each other in succession from page to page which makes the book rather difficult to read. This is not to say that the author does not attempt to summarise the work quoted and to indicate what in his opinion is the most probable conclusion. Thus the author's view of the process of blood coagulation may be briefly stated as follows: Part of the prothrombin of the plasma is loosely bound, but the greater part is firmly bound, the various proteins being looked upon as a colloidal co-ordinated complex rather than as separate fractions independent of each other. The loosely bound prothrombin unites with protein-phospholipin (cephalin) complexes from disintegrated platelets, to form thrombin, which rapidly unites with fibrinogen, releasing the firmly bound prothrombin, to react further with cephalin. He also considers that there are at least three methods by which plasma can be converted from a sol to a gel, and that it is a mistake to assume that one single process is always responsible for the formation of the fibrin clot.

The theoretical aspects of the subject are made the basis of correlating our knowledge of the

pathology and treatment of abnormal bleeding, and a useful appendix is given of the composition and actions of, and indications for, a variety of commonly used hæmostatics. The work will be of interest both to physiologists and clinicians, and further volumes in this series of monographs will be welcomed.

On Rous, Leucotic, and Allied Tumours in the Fowl: a Study in Malignancy. By Dr. J. P. McGowan. Pp. vii + 99 + 11 plates. (London: H. K. Lewis and Co., Ltd., 1928.) 10*s.* net.

The observations recorded by Dr. McGowan in this book are a sequel to his study of pernicious anæmia and allied blood diseases, in the course of which he investigated leucosis of fowls and noted sporadic cases of sarcomatous tumour. A detailed examination of these tumours and of the Rous sarcoma No. 1 now lead up to a study of the etiology of malignant growths, with the conclusion that sarcomatous tumours of fowls, including those of a leucotic nature, are probably caused by various non-specific irritants. Evidence is produced to support the thesis that these tumours are manifestations of disease of the hæmatopoietic tissues, the pathology of which is discussed in considerable detail.

Whether the evidence justifies the author's conclusions must remain at present a matter for individual opinion, but whatever this may be, it will be agreed that careful research such as Dr. McGowan describes cannot but assist in elucidating the problems of malignancy.

Metallurgy.

Impurities in Metals: their Influence on Structure and Properties. By Dr. Colin J. Smithells. Pp. xi + 157 + 23 plates. (London: Chapman and Hall, Ltd., 1928.) 18*s.* net.

Exact knowledge of the effects of impurities on the properties of metals is of fundamental importance to the metallurgist and engineer as well as to the physicist or chemist who uses metals as the subject of his researches. There is, therefore, ample justification for the publication of a volume treating specifically this aspect of metallurgy. Until the author took the subject in hand, no such book had been produced, but whether the present treatise is the one for which metallurgists have been unconsciously looking is quite another matter. The author himself states that he would have preferred to use the term 'minor constituent' instead of impurity, and it is certainly very difficult to justify the application of the word 'impurity' to, for example, the large amount of chromium deliberately added to the stainless steels, to which addition in fact these materials owe entirely their characteristic properties.

The effects of impurities on the mechanical properties of metals are quite inadequately treated. Industrially, the most important metallurgical impurities are probably sulphur and phosphorus in iron and steel. Of these, the former is dismissed in a few lines, and the latter scarcely mentioned. From the historical point of view, too, one would have expected at least a brief reference to the pioneer researches of Roberts-Austen and Arnold and Jefferson on the effects of impurities on copper and gold. None of these workers is even mentioned.

Although much interesting and useful information is made available in a handy form, the work leaves one with the impression that the range of the author's knowledge is too circumscribed to fit him for the task which he has undertaken. The book as a whole is disappointing, and the subject still deserves and needs a far more complete and balanced treatment. It is to the author's credit, however, that he had made us aware of the real need for a book treating as a whole the subject, some parts of which he has himself considered.

Cast Iron in the Light of Recent Research. By W. H. Hatfield. Third edition, revised and enlarged. Pp. xv + 340. (London: Charles Griffin and Co, Ltd., 1928.) 16*s.* net.

In spite of the extensive use of cast iron as a structural material, its scientific study has lagged conspicuously behind that of steel. Until quite recently, the knowledge of its constitution has been almost entirely empirical, and success in its use has been due to the practical skill of foundrymen rather than to an understanding of the factors which determine its constitution. Since the first edition of Dr. Hatfield's book was published, there have been determined efforts to remove this reproach, but a careful compilation such as this brings out the fact that even now we are very imperfectly acquainted with the constitution of cast iron, and therefore with the means of scientific control of its properties. For example, the relations between the sulphur and manganese contents of the iron are of the greatest importance in determining the degree of chill under given conditions, but the evidence is contradictory, and published work on the subject goes little beyond the knowledge of practical foundrymen. Even the relations between graphite, combined carbon, and silicon cannot yet be represented in a simple and intelligible diagram, and arbitrary assumptions have to be made concerning them.

Dr. Hatfield has included almost all that has been done on the subject, except in regard to the so-called 'pearlitic' irons, which might have received fuller treatment, and the new edition is valuable as a work of reference on a much neglected field of metallurgy. Unfortunately, the references in the foot-notes are frequently incorrect, probably through imperfect proof-reading, and the student who attempts to consult original papers may find himself at a loss. Apart from this defect, however, the book is to be commended to metallurgists as a compendium of facts. When the fourth edition is called for, it may be hoped that such progress will have been made in the scientific knowledge of cast iron that a systematic presentation of its metallography is possible.

C. H. D.

A Bibliography of Metallic Corrosion: comprising References to Papers on Ferrous and Non-Ferrous Corrosion (including Methods of Protection) published up to end of 1927. Greatly enlarged from a Bibliography prepared for the British Non-Ferrous Metals Research Association and privately issued to its Members. By Dr. W. H. J. Vernon. Pp. xi+341. (London: Edward Arnold and Co., 1928.) 21*s.* net.

THE literature of corrosion is extensive and at the same time widely scattered, so that a student of the subject feels the need of a bibliography more than in most branches of applied physical chemistry. Several attempts at such a compilation have been made, but certainly with less success than in the present work, which is likely to prove of great value to chemists and to metallurgists. At first sight it may be thought that the classification which Dr. Vernon has adopted is not the simplest, since there is no alphabetical index of authors, and the arrangement is one of many sections, each of which covers a definite part of the subject. After using the book for a short time, however, it is found that there is no difficulty in tracing any required paper the author of which is known, whilst a thorough system of cross-references ensures that the papers likely to have a bearing on any particular question can be traced with little effort. The bibliography has responded well to the test of looking for known memoirs.

There is no attempt to give the exact title of each paper, a short indication of the subject being given in English, but the original reference is accompanied by references to abstracts in the most accessible English and American journals. When necessary, a brief abstract is added, and this part of the work has been done judiciously, so that the reader is guided to essential papers without having to consult a large mass of material of no importance to his immediate subject. Dr. Vernon is to be congratulated on having performed a useful task with success.

C. H. D.

Miscellany.

History and Historical Research. By C. G. Crump. Pp. x+178. (London: George Routledge and Sons, Ltd., 1928.) 5*s.* net.

THIS is a delightful and stimulating little book. Mr. Crump held an important position in the Public Record Office for many years, but he writes in a spirit which would be equally becoming in a scientific laboratory. In fact, his essay is one of the best proofs we have seen of the essential similarity between all forms of work which aim at increasing knowledge of a living kind. Almost everything he says might be said with equal truth about scientific research.

Mr. Crump starts with the primary and fundamental necessity of an inquiring mind. Every researcher must be possessed with the desire to know. In this he only shares the characteristic which Aristotle assigned to the human species as a whole; when he adds to this the mark of wanting to know something new, or more about something than anyone else knows, he takes rank among original researchers—those who add to the sum of human knowledge. But in order to do this he must at starting be provided with a considerable equipment of general knowledge, and no part of Mr. Crump's book is better than where he dwells on the supreme importance of a well-trained mind in judging of the likely field for research and of the value of evidence, and in presenting it in a lucid and well-ordered form.

Two other admirable features stand out in this manual for the young researcher. One is the insistence on self-reliance. The choice of subject must be individual, and the professor, or older and more experienced colleague, should assist as friend and equal, not as dictator or superior. All the details of his method—the note-taking, and arrangement, the planning and writing of the book—will be subordinate to the main idea, and grow under his hand as he works. In short, the researcher, be he historian or man of science, is master of his own fate, and no one can make or mar it but himself.

Another attractive feature of the book is the style in which it is written, and the constant quiet humour which irradiates the whole. There is no better example of this than the analogy of the choice of a subject with the chase of a lion. The researcher has first to delimit the area in which he may find his quarry. This in itself demands wide knowledge and careful preliminary survey: by these the true haunts of the subject are ascertained. The searcher then advances, slowly and steadily testing and securing all the means of approach; and when at last the noble object of his quest stands before him, he is just as likely to be devoured by the quarry as to make it his own. The former indeed may seem as fine and fitting a reward as the latter.

F. S. M.

The Evolution and Classification of Soils. By Dr. E. Ramann. Translated by Dr. C. L. Whittles. Pp. xii+127. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin Marshall, Ltd., 1928.) 7*s.* 6*d.* net.

STARTING with a definition of soil, the author brings together many of the ideas and systems which have been developed throughout the world for its scientific classification. After discussing briefly the advantages and disadvantages of various methods of classifying soils, a system is adopted which, although almost too wide for general use, is not subject to the serious limitations of most of the older classifications. A soil is classified in accordance with its 'zone' (latitude and longitude) and its 'region' (depending on height, position, humid or arid climate, etc.).

Most soil workers nowadays have a little knowledge of the Russian pedological classifications and nomenclature, and this has proved in many cases a dangerous thing. Those who want to know the exact meaning of *podsol, tschernosem,* and similar terms frequently used and mis-used in recent works

on soils will find an excellent discussion on the subject in this book, although the author wisely avoids too drastic a use of modern Russian systems. Soils are but short-lived things compared with their geological neighbours, and our knowledge of their characteristics in bygone times is still scanty—but the paragraph on "Relic Soils" whets our appetite for more.

The translation, in spite of great difficulties, reads easily. Only one slight improvement might well have been made; it would have been better to have anglicised the transliteration of Russian names—the German transliterations offend the eye in an English book and are very apt to be misleading.

The Great Betrayal (*La Trahison des clercs*). By Julien Benda. Translated by Richard Aldington. Pp. x + 188. (London: George Routledge and Sons, Ltd., 1928.) 7*s*. 6*d*. net.

THE thesis of M. Benda's book is that the European *intelligentsia* have gone over to the enemy; that is to say, they have deserted the idealist ranks and joined the great army of the Philistines. It is not merely that the *intelligentsia* have become sceptics: they have actually transferred their allegiance, and devote themselves to detract and deride every form of idealism. For example, they lend themselves to "the intellectual organisation of political hatreds," and preach the doctrine of "sacred egotism." They display "the scorn for argument, the excess, the hatred, the fixed ideas" which we are accustomed to associate with the lowest forms of political propaganda. In short, they have prostituted their powers, and have become the militia of materialism. Even internationalism, which assumes imposing idealist airs, is inspired by bankers, industrialists, and trade unionists, whose aims are by no means disinterested.

The most notable betrayal has been an attack upon the intellectual ideal of truth itself, since "truth is a great impediment." There is now, for example, "a bourgeois truth and a working-class truth," and truth varies with frontiers. "Recently certain French thinkers waxed indignant that the doctrines of Einstein were accepted by their compatriots without more resistance." There is doubtless much ground for M. Benda's onslaught in some continental countries. But we do not think that British men of letters or of science have yet reached this stage of cynical barbarism. Yet the book is well worth reading. The translation is good.

J. C. H.

Physics.

Modern Physics. By Prof. H. A. Wilson. (The Student's Physics, Vol. 6.) Pp. xiv + 381. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1928.) 30*s*. net.

PROF. H. A. WILSON is best known for his experimental researches, but this book shows that he is also able to give clear expositions of the more theoretical aspects of modern physics. As he has himself recognised, the title is elastic, and not everyone will agree with his interpretation of it. In particular, most examinations demand a greater knowledge of the newer experimental methods and less of mathematical physics than is given here. The outlines of electromagnetic theory and electron theory are especially good, and furnish an excellent introduction to more pretentious treatises, whilst the two chapters on relativity are complete in themselves. The sections on the conduction of electricity through gases are good so far as they go, especially the chapter on flames, but too great weight has been given to the work of the Oxford school, and the treatment of the glow-discharge could well have been entirely replaced by an account of the precise methods for studying ionised gases at low pressures that have been developed in the last few years at Schenectady and at Princeton, the potentialities of which have still to be properly recognised.

The same general criticism applies to the other parts of the book that have an experimental bias. What is given is, nevertheless, concise and accurate. We have noticed only one incorrect statement: the photographing of the artificial disintegration of a nitrogen nucleus is erroneously attributed to Chadwick in the text (p. 225), an obvious slip, since the proper acknowledgment is made to Blackett on the corresponding plate (p. 131).

An Introduction to Physical Science. By Dr. Ivor B. Hart. Second edition. Pp. xii + 406. (Oxford: Clarendon Press; London: Oxford University Press, 1928.) 4*s*.

An Introduction to Physical Science. By Prof. James Rice. (Benn's Sixpenny Library, No. 115.) Pp. 79. (London: Ernest Benn, Ltd., 1928.) 6*d*.

THOUGH of the same title, these two books differ widely in treatment and in aim. The former, now in its second edition, has already proved useful for beginners in experimental science. Mechanics, heat, light, sound, and magnetism and electricity all find a place in its pages, the young student being introduced to these sections in some fifty experiments which he is himself to work through. Descriptions of numerous demonstrations and applications are also included, the whole being put together in a perfectly natural manner which cannot fail to attract. The arrangement is excellent, and the book is cheap at the price.

Prof. James Rice's book reads more like a retrospect than an introduction. To comment adequately on all the main branches of physics within seventy small pages requires very close packing. We cannot help feeling that the little book would demand a greater effort of concentration than the majority of uninstructed laymen would be willing or able to make. It does, however, provide a pleasant evening's reading for one who already knows, and it might with advantage be put into the hands of students at about the intermediate stage, for the purpose of providing a general survey of past work.

An Introduction to Advanced Heat. By Dr. Ivor B. Hart. (Bell's Natural Science Series.) Pp. vii + 336. (London: G. Bell and Sons, Ltd., 1928.) 7*s*.

THE title of this book has been chosen to indicate a standard beyond that usually reached in schools but somewhat below that expected of candidates for the highest honours in the first university degrees. The author assumes that his readers really know their elementary work; and even so they must draw a deep breath before plunging into the first chapter, which deals fully with the various scales of temperature.

Avoiding the snare of descriptive writing, the author sticks rigidly to his purpose of developing the theory of the subject until he has dealt adequately with the expansion of gases, both from the kinetic and the thermodynamic points of view. All this makes rather stiff reading, but the conscientious student can scarcely fail to have the satisfactory feeling that he is really plumbing the depths of his subject. He will find himself rewarded, at the end, by some more readable chapters, of which perhaps the best—certainly the most novel—is one relating to convection in the atmosphere.

Dr. Ivor Hart has already achieved prominence as a writer of more elementary books and as a biographer. In this latest excursion he is likely to be equally successful.

Intermediate Electricity and Magnetism. By Dr. R. A. Houstoun. Pp. x + 170. (London: Longmans, Green and Co., Ltd., 1928.) 4*s*. 6*d*.

THE title clearly indicates the scope of this book. Although it is written on conventional lines, there are many points in the arrangement which make for the orderly development of the subject in a student's mind, the sequence of the reading being unbroken by tedious descriptions of experiments and by reiteration in applications and examples. By concentrating in the earlier portion of the book upon the elucidation of main principles, the author has removed from the pupil the difficulty of sorting out the grain from the chaff—it is all good stuff. The technical applications of electricity, radioactivity, and 'wireless' are reserved for the end of the volume, after the fundamental ideas have already been formed. A good collection of questions and examples, inconspicuously printed, help to make up a really useful book.

An Outline of Physics. By Prof. A. E. Caswell. Pp. xiv + 773. (New York: The Macmillan Co., 1928.) 18*s*. net.

THIS book is an elementary introduction to physics which is very pleasant to read. It is written to appeal to non-mathematical students and to all who are willing to show a passing interest in physics. The conceptions necessary to modern physics appear quite early in its pages, and by gradual stages the reader is introduced to many of the most striking and most important results of modern research. Analogies are given freely—perhaps too freely, it may be felt, in one or two instances; but the author is always clear, and his final chapter, on the theory of relativity, is exceptionally well written.

War Office. Elementary Notes on Optics and their Application to Service Instruments. Compiled for Use in the Rangefinding Branch, Military College of Science, Woolwich, 1927. Pp. 128. (London: H.M. Stationery Office, 1927.) 3*s*. net.

A USEFUL little book which should fulfil its purpose very well, and give the military student of optics the guidance he needs in understanding the construction of his instruments. It may be suggested that the treatment of simple lenses is a little brief, a fuller discussion of the magnification at various conjugate distances would have been valuable when dealing with variable power telescopes. Also, in spite of the limitations of space, a few remarks on spectacles and on colour filters would have been useful to the service student.

Primary Physical Science. By William R. Bower. Pp. ix + 302. (London: Sir Isaac Pitman and Sons, Ltd., 1928.) 5*s*.

THE book deals with the rudiments of mechanics, heat, and chemistry along the lines laid down for the examination in preliminary technical science of the Union of Lancashire and Cheshire Institutions. For the most part the treatment is conventional, but good historical and biological notes are included. The book suffers from a certain lack of continuity in the reading, as is almost inevitable when a work serves the purpose of a laboratory manual, a text-book, a history of science, and a book of exercises, all in one.

Laboratory Physics: a Short Course. By H. W. Heckstall-Smith and B. A. Fletcher. Pp. vii + 224. (Oxford: Clarendon Press; London: Oxford University Press, 1928.) 4*s*. 6*d*.

THIS book is intended for use in all the laboratory work in physics which is necessary for the higher certificate examinations. Although there is little that is novel in the experiments which are described, the whole book is excellently arranged and it should tend towards good, orderly work in a school laboratory. It would also serve as a useful guide in any school where an advanced course in science is being developed.

Physiology.

A Text-book of Physiology. By Prof. William D. Zoethout. Third edition. Pp. 664. (London: Henry Kimpton, 1928.) 18*s*. net.

Laboratory Experiments in Physiology. By Prof. W. D. Zoethout. Pp. 251. (London: Henry Kimpton, 1928.) 10*s*. 6*d*. net.

THESE two books may be considered as complementary. In the text-book the author has set out to give an account of physiology suitable for dental students, and has attempted to steer his course between the larger text-books and the shorter elementary treatises. The work has reached its third edition in the course of a decade and has been thoroughly revised; it appears to be well up-to-date. The selection of material for such a book must be largely a matter of opinion, and depends in part on the courses required of the

students for whom it is intended; it may be recommended to all those who do not wish to read one of the larger works.

The other volume gives a fairly detailed account of experimental class physiology, including also a short section on chemical physiology. The experiments, however, are often unsuitable for a practical course in Great Britain, since they require the use of anæsthetised animals as subjects; some, doubtless, with suitable modifications could be carried out on the surviving carcass. Apart from this objection, the experiments described appear to cover the ground fairly completely and are probably more detailed than required by the average medical student. A number of the illustrations are taken from Jackson's "Experimental Pharmacology."

The A B C of Vitamins. By John Pryde. (The Vanguard Series.) Pp. 128. (London: John Hamilton, Ltd., 1928.) 2*s.* 6*d.* net.

THE aim of this short readable volume is to give the non-scientific reader a simple account of our present knowledge of the vitamins in non-technical language. The author appears to have succeeded very well in conveying the essentials of a complex subject to its pages, and the book should enable the numerous people who take an interest in their diet to choose appropriate foodstuffs or to exercise discrimination in their selection of a proprietary 'vitamin food.' We note that the author refers to vitamin B_2 as the growth-promoting fraction of vitamin B; as a matter of fact, animals, young rats for example, will fail to grow unless vitamin B_1 is supplied in the diet as well as vitamin B_2, so that both fractions are necessary for growth. Also it is stated that mammalian liver contains vitamins A and D: it appears probable that the latter is absent from mammalian liver, although fish livers provide a rich source of this vitamin. These criticisms, however, detract in no way from the usefulness of the book to those who wish to regulate their diet; but people should not be advised to give themselves ultra-violet irradiation in their own homes, owing to the dangers of possible over-exposure. The book is quickly read and can be recommended to the intelligent layman for perusal.

Übungen aus der vergleichenden Physiologie: Atmung, Verdauung, Blut, Stoffwechsel, Kreislauf, Nervenmuskelsystem. Von Hermann J. Jordan. Unter Mitwirkung von G. Chr. Hirsch. Pp. viii + 272. (Berlin: Julius Springer, 1927.) 18 gold marks.

THIS manual gives the course of laboratory exercises in comparative physiology which the authors have evolved for students of biology in their laboratory at Utrecht. Experiments have been selected which are readily performed by the student and require only easily obtainable biological specimens and apparatus, wherever possible, of a simple rather than of a costly character. The book deserves the attention of zoologists, since it is primarily biological and not merely an adaptation of medical physiology.

Psychology.

An Historical Introduction to Modern Psychology. By Dr. Gardner Murphy. With a Supplement by Dr. Heinrich Klüver. (International Library of Psychology, Philosophy, and Scientific Method.) Pp. xvii + 470. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1928.) 21*s.* net.

A PRELIMINARY glance at this very substantial volume—one of the largest in the important series to which it belongs—might cause one to wonder at certain of its features. Why, for example, should several pages be devoted to Alexander Bain, and only a few words to James Ward? The answer to this question reveals one of the many limitations which the unquestionably learned author has imposed upon himself. Bain stood strongly for the physiological approach, whereas Ward's contribution, though equally distinctive, consisted in applying evolutionary concepts to introspective analysis; and Dr. Murphy's main concern is to trace the changes which have led to an increasing emphasis upon the objective method of study, which has passed from the physiological to the experimental and quantitative methods so assiduously cultivated to-day. It is for this reason that such a thinker as Ward does not come much into Dr. Murphy's picture. The author has provided a most interesting and satisfying account of modern psychological developments in Europe and America. In a supplement, Dr. Klüver shows how recent German psychology has proceeded on lines of its own.

Practice, Fatigue and Oscillation: a Study of Work at High Pressure. By J. C. Flügel. (*British Journal of Psychology*, Monograph Supplements, 13.) Pp. v + 92. (Cambridge: At the University Press, 1928.) 8*s.* 6*d.* net.

THIS is the latest addition to the series of monograph supplements issued in connexion with the *British Journal of Psychology*, and is a good example of the kind of work which is being done by the scientific or objective school of psychologists at the present time—a school which has found great favour in America, but less in Great Britain. 'Fatigue' and 'practice,' and the relations between them, are familiar subjects of experimental investigation. By 'oscillation' is meant those short-period variations in efficiency usually referred to as fluctuations of attention.

Mr. Flügel's object has been to experiment, on a larger scale than has hitherto been attempted, with the view of discovering any general characteristics of these three functions, and also to apply statistical methods to the study of their inter-relationships. The thoroughness of his procedure, the extreme caution with which inferences are drawn, and the frank admission, or rather insistence, that complete success was not achieved in carrying out a rather ambitious programme, are all in the most exacting spirit of scientific method. It is on such studies as these that an important group of modern psychologists have hopes of real advance.

The Child in Primitive Society. By Prof. Nathan Miller. (Library of Educational Psychology.) Pp. v + 307. (London: Kegan Paul and Co., Ltd., 1928.) 12*s.* 6*d.* net.

THE scientific study of childhood assumes several different aspects, of which the physiological and the psychological have received much attention for several decades past. The sociological study of the child has not come so definitely to the front, although A. F. Chamberlain's book, "The Child: a Study in the Evolution of Man," stands as a good specimen of what could be done in this field a generation ago. Dr. Nathan Miller's is a timely addition to contemporary literature on the subject.

For the educator the value of the work before us lies in the fact that the position of the child in a modern complex society is made clearer by an examination of the part he plays in primitive society. From the broad scientific view such a study is of value because of the light it throws upon the mechanism of social heredity, for in the absence of a written language the child has necessarily been the chief means of perpetuating culture from one generation to another. Dr. Miller has used the method employed by Spencer, Frazer, Tyler, and others—the method of drawing upon the immense body of facts collected by trained observers, and by travellers among people of simple cultures. A most interesting and stimulating treatise is fortified by an extensive bibliography.

Technology.

Practical Color Simplified: a Handbook on Lacquering, Enameling, Coloring, and Painting, with special attention to Mixing, Choosing, Harmonising, Matching, Lighting, Testing, and Designation. By William J. Miskelle. (Practical Finishing Series, Vol. 1). Pp. xiii + 113 + 10 plates. (Chicago: Finishing Research Laboratories, Inc., 1928.) n.p.

THIS book sets out to provide a guide to a great many problems for the practical colourist, but in spite of its somewhat ambitious presentation of a colour circle, mixing triangle, harmonising triangle, and so on, there will be little to be gathered beyond the usual elementary facts of subtractive colour mixture that could not be very much more effectively learned by a really scientific approach to the subject. Arbitrary directions to mix so many parts of 'red' with so much 'blue' are apt to be misleading unless the mixer knows something about the red and blue to select. A knowledge of the spectral transmission or reflective coefficients of pigments, some notions of their relative staining powers, and the like, would form a very much sounder basis on which to build a discussion of real colour mixture.

The writer brings in some discussion of 'wavelengths' (he should note that μ stands for one micron, *not* a milli-micron) and has something to say on nearly everything from 'Shakespeare' to 'Old Glory,' but when in his chapter on "Colour Photography" (which ought to be headed "The Photography of Colours") he laments that "panchromatic plates are not generally available for the use of either roll film cameras or the amateur photographer," he must be prepared to make readers of NATURE somewhat nervous of his leadership. The book may be of some help to those who are prepared to accept his interesting methods of selecting colour harmonies.

Photographic Art Secrets: with a General Discussion of Processes. By Dr. Wallace Nutting. Pp. x + 133 + 105 plates. (London: Chapman and Hall, Ltd., n.d.) 12*s.* 6*d.* net.

"THE author has made many millions of photographs," although he confirms the statement that "there are only two perfect photographic days in the year," and in this volume gives his experiences in a series of ejaculatory statements of facts and opinions, but unfortunately does not distinguish between the two. He acknowledges that his *secrets* "may not be secrets to all who use cameras," but finds that the average amateur photographer does not know, or at least does not use his knowledge, of these matters. Scientific facts given are very few, this side of the art being evidently weak with the author; for example, he says "a plate consists of microscopic particles of nitrate of silver in an emulsion of gelatine." The author condemns exposure meters as requiring judgment in their use, "bothersome also because to consult it requires time," and "it is often impossible to use." Instead, he gives a table of proportional exposures according to the time of day and year, climatic conditions, and the character of the subject. We cannot indicate all the topics dealt with, as there are forty-two of them; these and the numerous illustrations, many of which are very nice and bear evidence to the author's skill, form a book that contains many useful suggestions that will inform the ignorant and refresh the memory of others.

The Finishing of Jute and Linen Fabrics. By Thomas Woodhouse. Pp. xxi + 346. (London: Macmillan and Co., Ltd., 1928.) 18*s.* net.

THE second edition of this standard work, which was originally published at 8*s.* 6*d.*, now makes its appearance at a considerably increased price. Unfortunately, a careful comparison of the new and old texts does not reveal as much new treatment of the original subject matter as one is led to expect from the preface. Nevertheless, several new features appear in connexion with recent developments in the various kinds of machines which are described, particularly in the case of bag sewing machines. References are made to modern applications of electric driving and heating, to safety devices, and to improved methods of mechanical adjustment. In addition, the chapter on waterproofing and fireproofing has been almost completely rewritten.

The author's work is usually characterised by excellent diagrams and illustrations, and this book is no exception.

Forthcoming Books of Science.

Agriculture, Forestry, and Horticulture.

Ernest Benn, Ltd.—The English Grass Orchard, A. H. Hoare; Farm Crops, A. W. Oldershaw and J. Porter. *Jonathan Cape, Ltd.*—A Modern Herbal, edited by Mrs. C. F. Leyel, 2 vols. *Chapman and Hall, Ltd.*—The Structure and Life of Forest Trees, an English translation of "Bau und Leben Unserer Waldbäume," Prof. M. Busgen, third edition, revised by Prof. E. Münch, translated by T. Thomson. *Gurney and Jackson.*—The Crop-Grower's Companion, J. Porter. *Macmillan and Co., Ltd.*—Text-Book of Tropical Agriculture, Sir H. A. A. Nicholls, second edition, revised by J. H. Holland.

Anthropology and Archæology.

G. Allen and Unwin, Ltd.—Memories of My Life, Prof. E. A. Westermarck; The "Soul" of the Primitive, Prof. L. Lévy-Bruhl, translated by Lilian A. Clare; The Origin and Development of Nationality, Dr. B. Joseph. *Cambridge University Press.*—Our Forefathers: The Gothonic Nations, G. Schutte. *Jonathan Cape, Ltd.*—The Heritage of Man, H. J. Massingham; Modern Chinese Civilisation, Dr. A. F. Legendre; The Story of the Gypsies, K. Bercovici. *Longmans and Co., Ltd.*—Race and Population Problems, Dr. H. G. Duncan; Poverty, R. Kelso (Longmans' Social Science Series). *Methuen and Co., Ltd.*—Studies of Savages and Sex, A. E. Crawley, edited by T. Besterman. *Oxford University Press.*—The Danube in Prehistory, Prof. V. Gordon Childe; Ashanti Law and Constitution, Capt. R. S. Rattray; Examples of Maya Pottery in the Museum and Other Collections, edited by the late G. B. Gordon, Part 2; Rock Paintings of Southern Andalusia, the Abbé H. Breuil and M. C. Burkitt, with the collaboration of Sir Montagu Pollock, Bart.; Biblical Anthropology, compared with and illustrated by the Folklore of Europe and the Customs of Primitive Peoples, H. J. D. Astley. *Kegan Paul and Co., Ltd.*—The Mongol in Our Midst: a Study of Man and his Three Faces, Dr. F. G. Crookshank, new edition; Witch Hunting and Witch Trials, collected and edited, with an Introduction, by C. L. Ewen; Greek Thought, and the Origins of the Scientific Spirit, Prof. L. Robin; The Court of Burgundy, O. Cartellieri; Life and Work in Prehistoric Times, Prof. G. Renard (The History of Civilisation Series). *Williams and Norgate, Ltd.*—The Antiquity of Man, Sir Arthur Keith, 2 vols., new edition; Further Discoveries in the Antiquity of Man, Sir Arthur Keith.

Biology.

Cambridge University Press.—Anatomy and the Problem of Behaviour, G. E. Coghill; An Introduction to the Study of Bird Behaviour, H. Eliot Howard. *Hodder and Stoughton, Ltd.*—How to Enjoy Birds, M. Woodward. *Oliver and Boyd.*—Dictionary of Scientific Terms, Pronunciation, Derivation, and Definition of Terms in Biology, Botany, Zoology, Anatomy, Cytology, Embryology, Physiology, I. F. Henderson and Dr. W. D. Henderson, second edition, revised and enlarged. *Oxford University Press.*—The Story of Our Knowledge of Living Things: The Evolution of Biology, Dr. C. Singer; Index Londinensis, an emended and enlarged edition continued up to the end of the year 1920 of Pritzel's Alphabetical Register of Representations of Flowering Plants and Ferns, Dr. O. Stapf, six volumes, vols. 1 and 2; The Plant-Life of the Balkan Peninsula: A Phytogeographical Study, Dr. W. B. Turrill; The Story of the Mosquito, J. A. Crawford and B. S. Chalam; Plant Hybridisation before Mendel, H. F. Roberts; The Principles of Systematic Entomology, G. F. Ferris. *Kegan Paul and Co., Ltd.*—Contributions to the Principles of Morphology, Dr. W. B. Crow. *G. P. Putnam's Sons, Ltd.*—Our Face from Fish to Man, Prof. W. K. Gregory. *G. Routledge and Sons, Ltd.*—Insect Singers: a Natural History of the Cicadas, Dr. J. G. Myers; Ants, Bees and Wasps, Lord Avebury, new edition, edited by Dr. J. G. Myers; Blue Blood in Animals, Prof. H. Munro Fox; Queer Fish: Essays in Marine Biology, Dr. C. M. Yonge. *Sheldon Press.*—Nature in Field and Meadow, W. P. Westell. *University of London Press, Ltd.*—Animal Psychology for Biologists, Dr. J. A. Bierens de Haar. *Williams and Norgate, Ltd.*—How Birds Live, E. M. Nicholson, new edition.

Chemistry.

Ernest Benn, Ltd.—The General Principles of Chemical Engineering, Prof. S. G. M. Ure; The Chemistry and Manufacture of Pigments and Paints, C. A. Klein, 2 vols. *Cambridge University Press.*—Molecular Rays, R. Fraser (Cambridge Series of Physical Chemistry); Elementary Qualitative and Volumetric Analysis, N. F. Watterson. *Chapman and Hall, Ltd.*—Hydrogen Ion Concentrations: their Determination and Industrial Importance, Dr. H. T. S. Britton; Industrial Carbon, Dr. C. I. Mantell; Electrochemistry, C. J. Broakman; Dusts, Smokes, Fumes and Odours in Industry, P. E. Landolt; The Liquefaction of Coal, F. C. Whitmore; Cracking of Petroleum, W. F. Faragher; Colloid Chemistry, J. Alexander (Industrial Chemical Monographs). *C. Griffin and Co., Ltd.*—The Analysis of Drugs and Chemicals, N. Evers and G. D. Elsdon; Vanadium, Niobium, and Tantalum, S. Marks (Friend's Inorganic Chemistry, Vol. 6, Part 3). *Crosby Lockwood and Son.*—Applied Chemistry: A Practical Handbook for Students of Household Science and Public Health, Dr. C. K. Tinkler and Helen Masters, Vol. 1, Water, Detergents, Textiles, Fuels, etc. *Methuen and Co., Ltd.*—A Concise Summary of Elementary Organic Chemistry, Dr. F. H. Constable.

Engineering.

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Geography and Travel.

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neglected by Dalton. The formulæ used by Higgins are also more related to modern formulæ than were those of Dalton.

SIR ERNEST RUTHERFORD delivered the first of a course of four lectures on "Molecular Motions in Rarefied Gases" on Mar. 2 at the Royal Institution. In recent years, much experimental work has been done in this interesting field of inquiry, and the results obtained are not only of theoretical importance but also of practical and industrial interest, as the construction and operation of high-speed pumps for production of the lowest vacua and the measurement of the minute pressures depend on an accurate knowledge of the motion of rarefied gases. An account was first given of the historical development of the kinetic theory of gases, with special reference to the early work of Waterston and Joule and the rapid development of the theory in its modern form by Clausius and Maxwell. Further progress has been made in recent years by Jeans and Chapman, while the experiments of Knudsen on gases of low pressure have resulted in notable contributions to our knowledge. It is only in the last few years that a definite experimental proof has been given of the velocity of molecules in a gas, and of the correctness of Maxwell's famous law of distribution. In the lowest vacua obtainable to-day, a molecule can travel more than 100 metres without a collision, even though there may still remain 40,000 millions of molecules in every cubic centimetre of the gas.

AN experimental Friday evening discourse was given on Mar. 1 at the Royal Institution by Sir Robert Robertson. After discussing the limitations of other methods of investigating infra-red radiations, a modern spectrometer, fitted with thermopile and galvanometer, was described; and by its means an absorption band of a gas (ammonia) was mapped. The origin of oscillation and rotation bands was then discussed. Oscillation bands are due to vibrations of the atom in a molecule. These are reflected in the main bands found in the infra-red both in emission and in absorption spectra, and frequently have a harmonic relationship with one another. Rotation of the molecule is shown by bands in the far infra-red and in the near infra-red by fringes imposed on the oscillation bands. From the difference in frequency of these fringes the moment of inertia of the rotating molecule can be calculated, from which values for the length of the molecule agreeing with those reached by totally different methods can be obtained. Mention was also made of the importance of infra-red spectra in the study of radiation given off in the processes of combustion and of explosion, in the investigation of stellar radiation and temperature, and the secular effects of differences in climate due to changes in intensity of solar radiation. Not only does this study afford valuable data for the theoretical physicist from the points of view of the quantum theory and wave-mechanics, but also it is becoming increasingly useful for determining chemical structure and suggesting molecular models. The dynamical behaviour of atoms in the molecule, and of the molecule itself as revealed by the study of this region of the spectrum, is a subject worthy of much more attention than is being given to it in Great Britain.

AT the annual general meeting of the Institute of Chemistry of Great Britain and Ireland, held on Mar. 1, Dr. Harold G. Colman presided in the absence of Prof. Arthur Smithells, who is on a visit to South Africa. The Report of Council showed that the roll of membership of the Institute at the end of January consisted of 1855 fellows and 3703 associates, in addition to nearly 700 registered students. The Meldola Medal for 1928 was awarded to Dr. J. A. V. Butler; the Sir Edward Frankland Medal and Prize to Cyril Fryer; and the Pedler Scholar for the year is Mr. George Morrison Moir. The chairman read an address from Prof. Smithells, in the course of which he stated that he considers the notion of making chemistry a closed profession is entirely impracticable. The Institute has been definitely entrusted with the duty, and already affords the means, of maintaining a register of chemists on which the Government, industry, and the public increasingly rely, but it does not adopt an unsympathetic attitude towards those outside its ranks who can usefully pursue a chemical calling. The Institute has every variety of chemist within its ranks and is truly representative of the profession. It is a living and growing thing, unconstrained by the rigidity of what is called machinery, and those who have sat at its Council table know that its work is pervaded by common sense and warmed by human feeling. The following officers were elected for the ensuing year: *President:* Prof. Arthur Smithells; *Vice-Presidents:* Mr. Arthur J. Chapman, Dr. G. C. Clayton, Mr. Ernest M. Hawkins, Prof. G. G. Henderson, Dr. R. H. Pickard, and Prof. J. F. Thorpe; *Hon. Treasurer:* Mr. Patrick H. Kirkaldy.

Two items of exceptional interest are recorded in Mr. Leonard Woolley's report on recent excavations at Ur (*Times*, Feb. 26). The first is a royal burial chamber of the First Dynasty in the form of a complete underground house, 40 ft. by 26 ft. In it there are four intercommunicating rooms with domed and corbelled roofs. The tomb had been plundered, but its importance lies in the fact that it is a new feature in Sumerian funerary custom and, as Mr. Woolley suggests, explains the large number of attendants slaughtered at a royal funeral; clearly it was intended that the royal mode of life should be continued in the next world in every particular. The second find, which holds out promise of future discovery, is a number of clay nodules with written tablets and clay jar-stoppers with archaic sealings. Although not so old as the pictographic tablets of Kish, they belong to a period hitherto represented only by rude clay figures of animals and men. They were found in a mass of rubbish stretching down from the walls of the earliest Sumerian settlement to the marsh or river. In such conditions there is reasonable expectation of finding pictographic material as early as that from Kish. The completion of the excavation of the great temple has now laid bare its vicissitudes for the whole period of the 2500 years of its existence.

THE electric meter has now been brought to a wonderful pitch of perfection. Considering the

hundreds of thousands of them that are continually rotating in Great Britain, it is wonderful that such a minute percentage ever have an average inaccuracy so great as two per cent. So accurate are they that they are sometimes used, with the addition of voltage and current transformers, to measure the power delivered by supply companies to tramway and manufacturing companies, meter bills of which amount to hundreds of thousands of pounds per annum. In this case, an error of one per cent means thousands of pounds per annum, and hence great precautions have to be taken to secure accuracy. Sometimes as many as six meters of various types are put in series and the average reading is taken as the true value. Possibly in this way a maximum inaccuracy not exceeding the half of one per cent can be assured. In order to secure sustained accuracy in service, it is necessary that the brake magnets remain constant and that the rotor bearings do not wear away. The latter problem is considered in a valuable paper read to the Institution of Electrical Engineers on Mar. 1 by W. Lawson. He gives a large number of experimental and statistical data on worn bearings. Various jewels which rank high in the scale of hardness have been utilised for the footstep bearing. Garnets, which were formerly used, are now discarded, and rubies and sapphires are generally used. It is claimed that artificial rubies and sapphires are more uniform in quality and slightly harder than the natural stones. In some cases the hardest known natural substance—diamond—is used and its use is increasing. The bearing surface is cupped as in other stones. Its manufacture in this form is a highly specialised art. The Birmingham Supply Corporation now uses these bearings for its large meters. For the last thirty years also they have been used in America.

IN his annual report to the Department of Overseas Trade (London: H.M. Stationery Office, 5*s*. net) J. R. Cahill, Commercial Councillor at H.M. Embassy in Paris, gives an interesting account of the electrical industry in France. Much of the prosperity of the country is due to the rapid development of this industry. In the manufacturing industry, combination has reached an advanced stage. Three or four groups of factories control the whole market. Competition, therefore, is not severe, and prices consequently decline at a slower rate. The electrification of French railways, particularly the Midi Railway, is making rapid progress. In April of 1927 the Midi Railway stated that electrification saved it 130,000 tons of coal every year. It now operates 500 miles of its system electrically, and aims at electrifying a further 687 miles in the next five years. The total capacity of French power stations is five million kilowatts, of which more than a third is due to water power. It operates more than 2000 miles of power transmission lines at pressures not less than 100,000 volts. The line connecting Bordeaux and Toulouse, which is 250 miles long, works at 150,000 volts. It is interesting to notice that water power is not developing so rapidly as thermal power. Possibly this is due to the fact that the prices for hydro-electric energy are State controlled. The possibilities in connexion with the extensive lignite deposits not far from Bordeaux for large steam stations are being considered. About 30,000 people are now employed for manufacturing radio apparatus. Although French exports of radio apparatus at present considerably exceed the imports, yet a considerable amount of radio accessories, particularly loud speakers, of British and American manufacture, are sold. In telephony, the automatic system is being adopted and many long-distance multi-core cables have been laid. As in Great Britain, the rapid progress of telephony has affected adversely telegraph traffic.

A CONVERSAZIONE and exhibition will be held in connexion with the coming-of-age celebrations of the Institute of Metals at the Science Museum, South Kensington, S.W.7, on Thursday, Mar. 14.

DR. E. J. ALLEN, F.R.S., secretary of the Marine Biological Association of the United Kingdom and director of the Plymouth Laboratory, will deliver the Hooker Lecture before the Linnean Society on Mar. 14, taking as his subject "The Origin of Adaptations."

AT the annual general meeting of the Quekett Microscopical Club, held on Feb. 12, the following officers were elected for the session 1929-1930: *President:* Mr. John Ramsbottom; *Vice-Presidents:* Mr. D. J. Scourfield, Sir David Prain, Dr. C. Tierney, and Dr. W. T. Calman; *Treasurer:* Mr. C. H. Bestow; *Secretary:* Mr. W. S. Warton.

IN commemoration of the bicentenary of Josiah Wedgwood in 1930, the Ceramic Society proposes to publish a volume of essays, for which two prizes are offered. The competition is not limited to members of the Society. All papers must reach the secretary of the Ceramic Society, North Staffordshire Technical College, Stoke-on-Trent, by Mar. 31, 1930.

A SPECIAL display of the film "With Cobham to the Cape" will be shown in the Empire Marketing Board Cinema at the Imperial Institute on Mar. 17 at 2.45 P.M. and 4.15 P.M., and on Mar. 18–20 daily at approximately 10.15 and 11.35 A.M. and 2.15 and 3.35 P.M. Admission is free, but schools in organised parties are requested to make application for seats to the Secretary, Imperial Institute, South Kensington, S.W.7, as early as possible.

THE Royal Society of Arts is offering two prizes under the Thomas Gray Memorial Trust for the improvement and encouragement of navigation; one, of £150, is for an invention in the years 1928 and 1929 of an improvement in the science or practice of navigation; and the other, £50, is for an essay on the navigation of a low-powered steamer in a revolving storm. Full particulars can be obtained from the secretary of the Royal Society of Arts, John Street, Adelphi, London, W.C.2. The competition closes on Dec. 31, 1929.

THE Council of the Iron and Steel Institute has this year awarded the Bessemer Gold Medal of the Institute to the Honourable Sir Charles A. Parsons, in recognition of his distinguished services in advancing the science of engineering as applied to the manufacture of iron and steel. The Williams Prize, of the value of 100 guineas, which was founded for the

encouragement of papers of a practical character by Mr. Illtyd Williams on his retirement in 1926, has been awarded in equal portions for the two papers, "Blast-Furnace Practice in Natal," by Messrs. J. E. Holgate and R. R. F. Walton, and "The New Plant of the Appleby Iron Co., Ltd.," by Messrs. A. Crooke and T. Thomson.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A junior engineer under the Safety in Mines Research Board in connexion with research on colliery wire ropes—The Under Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1 (Mar. 15). An assistant for work in connexion with research on water pollution—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, Westminster, S.W.1 (Mar. 20). A temporary junior forestry inspector under the Government of Northern Ireland—The Secretary, Civil Service Commission, Northern Ireland, 15 Donegall Square West, Belfast (Mar. 23). An assistant agricultural chemist at Institute of Agriculture, Kirton—The Principal, Institute of Agriculture, Kirton, near Boston, Lincs. (Mar. 27). A principal of the new farm institute of the Kent Education Committee at Borden—The Agricultural Organiser, Springfield, Maidstone (Mar. 30). A senior lecturer in psychology at the Rhodes University College, Grahamstown—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (April 1). Male cartographers in the Hydrographic Department of the Admiralty—The Secretary, Civil Service Commission, Burlington Gardens, W.1 (May 23). A research chemist at the Cardiff City Mental Hospital—The Medical Superintendent, Cardiff City Mental Hospital, Whitchurch, near Cardiff. A director of research under the J.A.C. Committee, with graduate qualifications in agriculture, botany, and chemistry, and some experience in conducting field experiments—N. Hackett, Kingswood, Bingley, Yorkshire. A junior assistant under the directorate of explosives research, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18.

Our Astronomical Column.

JUPITER AND VENUS.—On Mar. 14 a conjunction of Jupiter with the new moon will be very interesting for two reasons, namely, the near approach of the two bodies, and the convenient hour at which it happens. The event will take place on Mar. 14, at about 10 P.M., at which time Jupiter will be apparently distant from the north limb of the moon about four-tenths of a degree only. The picture afforded by these objects so near together will be enhanced by the presence of the brilliant planet Venus lying about 10 degrees north-west of the others. Jupiter is now becoming fainter with increasing distance from the earth, but Venus will attain its maximum brilliancy on Mar. 15, and shine with striking lustre amid the twilight of the north-west. This planet is now travelling sunwards and will disappear from the evening sky after the middle of April, but will return to view in the morning twilight of May.

MARCH METEORS.—There are no special displays of meteors recurrent in March, but fireballs are fairly prevalent. Though meteors are not abundant they will deserve special attention, for March and the other spring months have been much neglected in past years. A few careful observations in March are, therefore, worth a large number obtained in the summer or autumn months when investigations in this field have been already conducted to a considerable extent in past years.

During about the third week in March, meteoric radiants at $161° + 59°$ and $312° + 79°$ have been occasionally exhibited, and there are really a great number of feeble systems slightly manifested, but possibly many of these are relics of ancient displays now very attenuated by frequent encounters with the terrestrial atmosphere in past ages.

AURORA BOREALIS.—On Wednesday evening, Feb. 27, an unusual and striking display of aurora was observed from various parts of Great Britain. It has been described as the Zodiacal light, but the exhibition appears to have been of too brilliant a character to be considered as formed by the latter phenomenon. A correspondent at Burnham-on-Sea noticed the strange light just before 10 P.M. Its aspect was that of an intensely coloured band stretching across the northern horizon. It remained some time and passed slowly in a direction far to the westward. The beam was strikingly luminous and finally disappeared soon afterwards.

Accounts have come from many stations descriptive of the event and of the change in position and location which the chief feature assumed. Several people thought it a remarkable meteoric fireball with very slow motion and long duration.

From the south coast of Devonshire, and from Wiltshire and other stations, observers refer to the vivid nature of the spectacle. It was first detected at about 9.30 P.M. and had nearly disappeared from view 20 minutes afterwards. Mr. B. G. Hoare, writing from Inverness, states that the display was visible from 8.30 P.M. until midnight. At some stations streamers of pale light ascended from the horizon to considerable heights and were traceable at the zenith. Changes constantly affected their intensities and positions. The cloud or luminous band was the most conspicuous feature and its variations were very notable. It drifted westwards, and in its transit passed over numbers of the stars, which, however, remained distinctly visible in many cases.

THE CATANIA ASTROGRAPHIC CATALOGUE.—The Catania Observatory undertook the zone between North Decl. 46° and 55° in the Astrographic Catalogue. It has had many difficulties to surmount through deaths of directors and shortage of funds, but is now issuing instalments of the Catalogue at short intervals under the direction of Prof. G. A. Favaro. The two latest instalments (vol. 7, part 2, decl. 52° to 54°, R.A. 3^h to 6^h; and vol. 8, part 2, decl. 53° to 55°, R.A. 3^h to 6^h) have lately been issued; it will be seen that decl. 53° to 54° is common to both volumes. The catalogue gives both the rectangular co-ordinates and the R.A. and Decl. for 1900·0 for every star. Most of the observatories limit themselves to rectangular co-ordinates, but Catania having once embarked on the more ambitious programme is unwilling to relinquish it. It has of course many conveniences; the separate determinations for each star are immediately comparable without any reduction. The faintest magnitude included is 12·0.

Research Items.

The Teeth of Aboriginal Californians.—Dr. R. W. Leigh has made a study of pathological conditions in the teeth of three hundred crania of Californian Indians in the University of California Museum of Anthropology, which is published as No. 10 of Mem. 23 of the University's *Publications in American Archæology and Ethnology.* The specimens were derived from pre- or early post-conquest times when food habits had not been materially affected by Caucasian contact. Although food varied according to area, acorns and small seed food constituted a larger part of the diet than any other food. The grinding process for acorns, seeds, etc., was universal, and apparently this had deleteriously affected the teeth. The habitual eating of tobacco, especially when mixed with lime and mussel shells, and its use as an emetic, also affected the teeth. Other causes affecting the teeth were leaching of food with sand and cooking with hot stones. Much abrasive material was thus introduced into the mouth, and attrition, with its sequelæ, is the conspicuous dental lesion in the majority. Seventy per cent of persons more than forty years of age had the pulp of one or more teeth exposed. Dental caries occurred in 25 per cent, though specimens from the shell mounds showed the low rate of 12 per cent. As a result of pulp exposure and necrosis, 52 per cent showed dissolution of continuity of bone surrounding the apices of the teeth—a result of attrition. Few teeth were lost before middle life—only ten dying at less than forty years of age had lost any teeth, and most cases were well over fifty years. More superior than inferior teeth were lost.

Wooden Dolls from West Africa.—In *Man* for February, in the course of notes on the Wamakonde of Portuguese West Africa, Mr. H. D. Collings describes some remarkable little dolls of wood. The Makonde are very clever wood carvers, and these dolls are among the best things they made. They range in height from one to two feet. Their use is unknown, but coast natives state they were used in dances. They are carved in a soft white wood with a large central hole which is filled with pith. The wood is worked when green. Of two figures which are illustrated, one about 16 inches in height represents a woman. The upper lip is distended by the lip ornament, an ebony ring, and the face is covered by the usual tribal marks. The front teeth are pointed as are the teeth of the Makonde—a tribal mark. Real human hair had been driven into the head by a screwdriver-like implement. A small piece of wood has been left to join the left hand to the body, a peculiarity noted in nearly every specimen. The male figure has no tribal marks and the hand is not connected with the body. This figure is stained red with some vegetable substance, the eyes being left white. The models stand upright alone when placed on their feet. They are not common, and few natives know how to carve them. The smoking pipes of this people are also of some interest. They are of the water-container type, the container being a young coconut shell which is fitted with two bamboos, one of which has a movable pottery bowl. In a more elaborate form which is described, a curved central strengthening piece of wood is carved with decorative designs very similar to the tribal marks.

Nesting Habits of Oropendolas.—The oropendolas build long pendant nests in colonies, and although they are familiar enough in tropical America, no connected study of their habits has been made. Frank M. Chapman has repaired this omission by an intensive study of the oropendolas (*Zarhynchus wagleri*) of Barro Colorado Island (*Bull. Amer. Mus. Nat. Hist.*, vol. 58, 1928). In the nesting colonies, which set to work very regularly about the first week in January, females outnumber males by about six to one, and yet it would appear that each male has only one mate—at a time—and that in view of the abundance of choice there is no marked display of sexual jealousy. The males take no part in the selection of the site, in the gathering of building material, the construction of the nest, the incubation of the eggs, or the feeding of the young. But they guard the females from the attacks of hawks during nest-building and generally act as watchmen. The long swinging nest hangs from the upper branches of a tree, and the building of the bag, woven of tendrils, fine strips of bark, and plant-fibres, with its contained nest proper, occupies one month. The male never enters the nest, but the female sleeps there, and lays two eggs which hatch after an incubation period of 17 days. A month later the young leave the nest. There is no attempt at concealment, either in the position of the nest or in the bright colours of the birds themselves. Their safety depends on a constant vigilance, and on a spontaneous dive headlong into the dense vegetation, which is never far distant, when the alarm note is sounded.

New Zealand Fishes.—In a paper entitled "Studies in New Zealand Fishes" (*Proceedings of the New Zealand Institute*, vol. 59, Part 2, 1928), Mr. L. T. Griffin, assistant curator of the Auckland Museum, describes several little-known fishes and two new species. These include a large eel, *Gymnothorax nubilis*, the only specimen so far recorded from New Zealand, previously known from Norfolk Island and the Indian Ocean and Archipelago. This individual measures 640 mm. in length. *Serioella amplus* n. sp. is interesting, as it apparently does not vary as do the other species of the genus. It is a fine fish and very plentiful, which makes it all the more curious that it has not been described before. The mackerel described, *Scomber australasicus*, is said to be very common in deep water beyond the Hauraki Gulf, moving about the coast in large shoals, and is also common in Australian seas. The specimen of the striped angler, *Antennarius striatus*—a most grotesque creature with two pyramidal humps on its head and a lure resembling a three-fronded piece of alga—was found hiding in a bunch of seaweed. Most of the species of this genus live in seaweed floating in tropical seas, and by filling the spacious stomach with air are able to keep near the surface of the water. In this way they can live in the open sea as well as near the coast, but they are very poor swimmers and drift with the currents into various places. This paper is exceptionally well illustrated by good original drawings.

The Anatomy and Habits of the Lophogastrid Crustacea.—The Lophogastrida, including the genera *Lophogaster* and *Gnathophausia*, have long been regarded as among the most primitive Mysidacea, and Miss Manton (*Trans. Roy. Soc. Edin.*, vol. 56, pt. 1, No. 5, 1928) has examined specimens of these genera in the light of the recent work on the feeding mechanisms of the Malacostraca which we owe to Miss Manton herself and to Prof. H. G. Cannon. Miss Manton finds that *Gnathophausia* has mouth parts of the typical filtratory form, and must, therefore, be at least a partial filter feeder. The mechanism is, however, more primitive than in any other living Malacostraca by reason of the absence of an auxiliary food current

created by the thoracic exopodites. Locomotion is effected by the abdominal pleopods entirely, and the thoracic exopodites mainly cause currents of water bathing the gills. *Lophogaster*, on the other hand, is a bottom living form, incapable of filter feeding. The mouth parts are modified for feeding on large food masses, and the modifications resemble those found in the higher Peracarida which have given up filter feeding. The mandibles of the Lophogastrida compared with those of other Malacostraca appear to be primitive in form, and to show the origin of the *lacinia mobilis*. The author has also investigated the segmentation of the abdomen and the muscular system of the terminal 'segment' in *Lophogaster* and *Gnathophausia*, and finds that the groove across the last 'segment' of the abdomen in the Lophogastrida represents the junction between the incompletely fused sixth and seventh segments. In a previous paper the author has shown that the last abdominal segment in the adult of *Hemimysis* is formed by the complete fusion of the separate sixth and seventh segments present in the embryo. In the Lophogastrida the fusion between these segments is therefore incomplete. This interesting observation brings the segmentation of the Eumalacostraca into line with that of the Leptostraca (*Nebalia*), where a completely separated but limbless seventh segment in the abdomen is a feature of the adult condition. Miss Manton concludes that the Lophogastrida are the most primitive living members of the Malacostraca.

Philippine Woods.—In the May number of the *Philippine Journal of Science* Mr. Josè C. Espinosa, of the Bureau of Science, Manila, discusses "Strength Properties in relation to specific gravity of Philippine Woods." The paper, which is illustrated by five text figures, is of a technical nature and designed for research workers in this branch of investigation. The strength properties of wood have a certain definite relation with its density or specific gravity. Newman and Wilson have carried out an analysis of 200,000 tests at Madison for American timbers, and L. G. den Berger in the Dutch East Indies has worked on teak. Mr. Espinosa has carried out about 45,000 tests for some of the more valuable Philippine timbers and presents their relationships both in graphical and in equation form.

Glacial Drifts and Erratics.—The Yorkshire Geological Society and Sir Sidney Harmer have laid British geologists under a debt of gratitude for making possible the posthumous publication of a paper on "The Distribution of Erratics and Drifts" in England and Wales, accompanied by a beautifully layer-coloured contoured map on which the distribution is effectively displayed, both paper and maps being the work of the late F. W. Harmer (*Proc. Yorks. Geol. Soc.*, November 1928, pp. 79-150, and sold separately by John Bartholomew & Son, Ltd., Edinburgh. 10*s*. with folded map, or 11*s*. with unfolded map on a roll). Mr. Harmer had a personal familiarity with the drift deposits extending over some sixty years, which was unrivalled in extent and achievement, and the invaluable result of this long service to geology is the first detailed mapping of erratics in England and Wales. The map itself is on the 1/*M* scale and measures about 20 in. × 25 in.; it includes southern Scotland south of Peebles and Lanark. The contour interval is 100 ft. up to 600 ft.; thereafter the contoured levels are 1000 ft., 1500 ft., and 2000 ft. By the use of an ingenious system of twelve distinctive symbols printed in heavier colours than those used for the contour intervals, the following varieties of drifts and erratics are recorded: North Sea; Chalky Boulder Clay (chalk matrix); Chalky Boulder clay (Jurassic matrix); Pennine (Carboniferous); Pennine (Silurian); Welsh; Lake District; Cheviot and Galloway; Bunter Pebble; Charnwood; Eocene of Herts; and Neocomian (erratics of large size). The map is a masterpiece of clarity and accurate registration. The very high cost of reproduction has been made possible by the generosity of Sir Sidney Harmer and his co-trustees under his father's will. It will interest many readers to know that the original map has been presented to the Geological Survey and Museum in Jermyn Street.

Irrigation in India.—The Triennial Review of Irrigation in India, of which the issue for 1924–27 has now been published by the Government of India, contains much useful statistical information. It recounts the progress of irrigation in the various provinces of British India, and gives financial statistics for all the irrigation works. The irrigated area is now a little more than twenty-eight million acres. In productive irrigation works every province shows an improvement compared with the previous triennium. The irrigated area is as much as 88 per cent of the total cropped area in Sind, and averages for the whole of British India 12·8 per cent, being naturally very low in Bengal, Bombay, Orissa, and the Central Provinces. Not the least valuable part of the pamphlet is the account given of the various irrigation projects in each province.

The Origin of Magnetism.—The issue of the *Physikalische Zeitschrift* for Dec. 15 contains an account by Dr. O. V. Auwers of recent work on the question why certain substances are magnetic and others not. According to Heisenberg, each atom of a magnetic element must have at least 8 neighbouring atoms of the space lattice at equal distances from it. According to the author, an examination of magnetic elements furnishes no direct contradiction to this law. But when magnetic α-iron passes into non-magnetic β-iron, or magnetic α-nickel into non-magnetic β-nickel between 700° and 800° C., there is no distinct change in the space lattice of either. Alloys of two of the magnetic elements, iron, nickel, and cobalt are sometimes non-magnetic although the space lattice suggests by Heisenberg's rule that they should be magnetic. On the other hand, iron pyrites and magnetite are both magnetic, although they do not conform to the rule. At present, therefore, we appear to have no satisfactory explanation of the origin of magnetism.

Absorption of Penetrating Radiation.—The only method yet devised for analysing the spectrum of the cosmic rays is to find by experiment how their intensity falls off in their passage through matter, and then to calculate the wave-lengths which correspond to the observed coefficients of absorption by making use of some specific theory of the interaction between radiation and electrons. The two principal absorption formulæ which have been employed are those associated with the names of Prof. A. H. Compton and of Dr. Dirac, but recently a relation with a better theoretical basis has been proposed by Klein and Nishina (see Nature, vol. 122, p. 398). In interpreting the absorption curves it is also necessary to consider precisely what is registered by a γ-ray electroscope, and a new analysis of the problem by L. H. Gray (*Proceedings of the Royal Society*, vol. 122, p. 647, Feb. 4), in which all of these factors have been taken into account, has shown that the wave-lengths which had previously been accepted as correct are probably in need of considerable revision. The formula of Klein and Nishina is not only the most satisfactory of the three theoretically, but it also agrees best with the somewhat meagre data which are available concerning the absorption of γ-rays of known frequency. If this is adopted, the principal rays in the spectrum of the

penetrating radiation work out to be of even shorter wave-length than Prof. Millikan and Dr. Cameron had supposed, and have quanta of 90, 360, and 920 millions of electron-volts respectively. The last number corresponds to the annihilation of a mass almost exactly equal to that of a proton, whereas Prof. Millikan and Dr. Cameron had suggested that it arose from the catastrophic condensation of a number of hydrogen nuclei and electrons to form the nucleus of an atom of silicon, magnesium, or aluminium.

RADIO ACOUSTIC POSITION FINDING.—In order to construct the nautical charts used in the navigation of ships it is essential that accurate hydrographic surveys be periodically made. In this way sunken rocks, reefs, and wreckage are accurately charted. One of the methods, developed during the War, of locating objects is to utilise the difference between the speed of radio waves and under-water sound transmission. Many difficulties had to be overcome, such as the failure of sound to carry under certain conditions and the interference at shore stations. The U.S. Coast and Geodetic Survey has published a useful booklet (*Special Publication* No. 146, price 20 cents) giving a clear and full account of the method and details of the instruments used by the survey ships operating on the Pacific Coast of the United States. Radio acoustic control has been used for the last four years and has proved of great value. It can be used regularly up to a distance of 70 miles from the shore, but in special cases it has been used at 200 miles. It is independent of fog, but during storms the noise of the waves breaking on the beach sometimes causes difficulty. The under-water sound is obtained by exploding a bomb, and the noise is picked up by a suitably placed receiver connected through an amplifier to a relay, both the sound and the radio signals being amplified. A chronograph with two pens marks the instants when the sound and the radio signals are received. The time taken by the sound travelling through the water to two stations on the coast is observed. Hence since the velocity of sound in sea water of known salinity and at known temperature is given by tables, their distances can be found, and the ship's position obtained. Sometimes the noise made by fishing boats anchored near the sunk hydrophone makes it impossible to distinguish which are the bomb noises. The only remedy is to remove the boats. Another source of trouble was traced to fish bumping against the hydrophone box and to crabs climbing over it.

CHEMICAL EFFECTS OF CATHODE RAYS.—The *Journal of the American Chemical Society* for December contains three papers on the chemical effects of cathode rays. The first two papers, by A. L. Marshall, deal with the formation of ozone and the union of hydrogen and oxygen effected by cathode rays from a tube operated at 200 kv. and 0 001 amp. Cathode rays bring about the ozonisation of oxygen and also the decomposition of ozone, the reaction taking place entirely in the gas phase. A steady state is reached corresponding with a concentration of 1 molecule of ozone to 1700 of oxygen. The silent discharge produces a concentration of 1 in 12, but has a much smaller decomposing effect than the cathode rays. The reaction is uninfluenced by the nature of the walls of the containing vessel. In the reaction between hydrogen and oxygen brought about by the rays, it was found that the primary products are hydrogen peroxide, water vapour, and ozone. The rate of formation of the peroxide is independent of concentration, whereas the rates of formation of water vapour and ozone, which parallel one another, are both changed by variations in concentration. It is suggested that both water vapour and ozone are produced by the same primary mechanism. The third paper, by W. F. Busse and F. Daniels, is concerned with the chemical effects of the rays on oxygen, air, nitric oxide, and carbon dioxide. These effects were expressed as the ratio of molecules produced per electron crossing the cathode ray tube, and were: nitric oxide decomposition 230, ozone from oxygen 100, ozone from air 44, nitric oxide from air 14, carbon dioxide decomposition 3. The results described in all three investigations show that there is a close similarity in the chemical behaviour of cathode rays and α-particles.

ATOMIC WEIGHT REPORTS.—Since the International Committee on Atomic Weights has not provided a table since 1921, the Report and Table of Atomic Weights prepared by the Sub-Committee of the Chemical Society (*Journal of the Chemical Society*, pp. 216-219; 1929) and those prepared by the German Atomic Weight Commission (*Berichte*, vol. 62, pp. 1-23) afford an interesting basis for comparison. It is satisfactory to note that of the eighty-four elements tabulated, only fourteen differ in more than one unit of the last significant figure in the heights assigned to them by the two tables. Of these, the more important are carbon, sodium, phosphorus, and arsenic, for which the English Sub-Committee adopt the values $12{\cdot}003_6$, 23·000, $30{\cdot}98_2$, and $74{\cdot}93_4$, respectively (last figures are uncertain), on the basis of the results obtained by Aston with the mass-spectrograph; the German values are 12·000, 22·997, 31·62, and 74·96 respectively. For magnesium (24·30, 24·32—the English value is given first in each instance), calcium (40·09, 40·07), chromium (52·04, 52·01), manganese (54·95, 54·93), niobium (93 3, 93·5), gadolinium (157·0, 157·3), and tantalum (181·3, 181·5), the English value is that recalculated by F. W. Clarke in 1919, since when there have been no new determinations. There remain silicon (28·08, 28·06), copper (63·55, 63·57), and thorium (232·15, 232·12), with which there is no immediately obvious reason for the slight differences. Interesting features are, in the German Report, the provisional atomic weight 188·71 for the newly discovered element rhenium (Re), which has been investigated by Walter and Ida Noddack, and in the English report the arrangement, for the first time in an annual atomic weight table, of the elements in the order of their atomic numbers.

FLAMES IN NITROUS OXIDE.—The normal infra-red spectrum derived from a flame is usually that of the products of reaction and not of the reacting gases. This may arise from the fact that in most cases the supporter of combustion is oxygen or air, which are without characteristic infra-red spectra. In the *Journal of the Chemical Society* for January, Bailey and Lih describe experiments on the emission spectra of gases burning in nitrous oxide. In the case of carbon monoxide and coal gas, the anticipated spectra of water vapour and carbon dioxide were found, but a different result was obtained with hydrogen. The flame of a mixture of this gas with nitrous oxide is very complex and consists of at least five zones, but the normal type of spectrum due to water vapour is shown. When, however, a hydrogen jet is burned in nitrous oxide, a new spectrum appears, some bands of which appear to correspond with known absorption bands of nitrous oxide. This new spectrum is not exhibited by carbon monoxide or coal gas in either mode of burning, and is probably due to some form of stimulation by burning hydrogen molecules. It does not appear in the coal gas flame and is then probably inhibited by the carbon monoxide present. Hence the stimulation is probably not merely thermal.

British and Foreign Ammeters and Voltmeters.

AT all electric generating and distributing stations large numbers of ammeters and voltmeters are fixed on the switchboards so that the attendants can see at a glance how the various electrical machines are working. The manufacture of these instruments is quite an important industry, and we are glad that the manufacturers in Great Britain are thoroughly aware of the necessity of continually improving the design and accuracy of their instruments in order to meet foreign competition. One sometimes hears from an engineer that a particular foreign instrument maker makes the best instruments, but there is no general agreement as to which foreign firm makes the 'best,' or in what respect these instruments are better than those made in Great Britain. An investigation was therefore initiated by some of the members of the British Scientific Instrument Research Association to find out whether there was any foundation for these reports. It was thought also that a careful comparison of the types of instruments made in America, Europe, and Great Britain would be of value, as it might suggest to makers improvements in the design of their instruments.

To bring the inquiry within manageable limits, it was decided to restrict the investigation at first to permanent magnet moving coil instruments, and we have received a synopsis of the detailed report circulated to members of the Research Association. For obvious reasons the names of the manufacturers are not mentioned, but the instruments are classified under the headings of British and foreign, and a critical and impartial account is given of their design and performance.

The manufacture of these instruments has lasted over so many years that the general lines of their design have become almost universal. To obtain certain characteristics, however, different methods are adopted, and it is necessary to make compromises at almost every point in their manufacture, the instrument being judged on the general 'balance' obtained. Users of instruments have generally definite preferences due to a liking for some particular detail in the design. Not infrequently these preferences have no specific foundation and are merely personal.

The instruments tested for the Association were 'dial type' switchboard ammeters and voltmeters varying from six to eight inches in diameter. They were examined for rapidity of indication, accuracy, effect of temperature, internal construction, nature of the springs and of the magnetic system, appearance, and kind of pointers and dials used.

In some of the instruments examined the damping was much too small. When switched into the circuit the pointer moved over the scale in its first swing and struck violently against the stop at the upper end of the scale. In some cases, also, there was a tendency for the pointer to stick at the upper end of the scale. In other cases the pointer oscillated for some time before coming to rest. The conclusion is arrived at that in the best instruments the damping should be almost but not quite critical; that is, that the pointer should swing slightly beyond its final position but return rapidly to it.

Of the instruments examined, 60 per cent were accurate to within 1 per cent, 30 per cent had errors between 1 and 2 per cent, 8 per cent had errors between 2 and 3 per cent, and one instrument had an error of more than 9 per cent. The general level of the accuracy of the British instruments was at least as high as that of the foreign instruments.

The instruments were affected in very varying degrees by temperature. Some of them were specially compensated for temperature. In one of the British instruments the compensation was practically perfect from 10° to 50° C., the sensitivity of the instrument being constant to within one or two parts in one thousand over this range. It appears that compensation for temperature can be provided to a satisfactory extent by a proper choice of the materials used in the moving coil circuit, control springs, shunt, etc. The arrangements for zero adjustment were very varied. In one case it was necessary to open the front of the instrument case to make the adjustment, but in another the arrangement was very neat and efficient.

The practice of fitting resilient supports to the jewels is to be commended, as it affords considerable protection against the risk of damage due to vibration or mechanical shock. The instruments of two British manufacturers who follow this practice have a distinct superiority in this respect over all the others. Some of the manufacturers use copper wire for their coils and others aluminium. The use of aluminium has certain advantages, but it is difficult to solder. Phosphor bronze springs were used by all the manufacturers for their instruments. Only in two of them was the position of the zero reading of the pointer found unchanged after they had been in circuit for seventy-two hours. The pointers came back to their original zero positions after intervals varying from a few minutes to twenty-four hours. It was found that instruments with large air-gaps in their magnetic circuits were not necessarily inferior to those having smaller air-gaps. It is necessary, however, to maintain a proper relation between the magnetomotive force of the magnet and the reluctance of the magnetic circuit.

So far as the external appearance of the instruments is concerned, it is best that only the scale and the pointer should attract the eye. Full white dials and bright lacquered brass cases are not desirable. It was found that certain scales were easier to read than others, and this was attributed to a better balance between the thickness of the gradations and their height. The instruments were not tested to determine the extent to which their indications were affected by external magnetic fields. We think that this was a pity, as many switchboard instruments are seriously affected in this way. It is stated, however, that inspection of the instruments showed that some would be affected much more than others.

In conclusion, the report says that the best of the instruments examined, both British and foreign, were well suited for the purpose for which they were designed. Two pairs of instruments of British manufacture were open to criticism in respect of certain details of construction, and two pairs of foreign instruments were distinctly inferior both in design and construction. None of the instruments showed an outstanding superiority over all the others in every particular. If the instruments are placed in order of merit as assessed on some particular criterion of excellence, the instrument placed first would in many cases be a British one. Certain of the British instruments examined would occupy high positions whatever criterion were chosen. The consistently high positions occupied by certain British instruments in the tests described above leads to the conclusion that the best-known British instruments of the kind examined are quite equal to the best-known corresponding instruments of foreign origin.

The Timber Resources of the British Empire.

ACTING under a resolution of the Imperial Conference which sat in London in 1928, an Imperial Economic Committee was appointed consisting of nominees of Great Britain, the Dominions, India, and the Colonies and Protectorates. The Imperial Conference directed the Economic Committee to prepare for the consideration of Government a list of raw materials suitable for inquiry on the lines of the Committee's reports dealing with foodstuffs. In 1927 the Governments of the Empire agreed that the Committee should prepare such a report on timber. This report (*Rep. of Imp. Econom. Committee*—Tenth Report—Timber. London: H.M. Stationery Office, 1928) has been recently published. It is based on the examination of a number of witnesses representing producing, marketing, and manufacturing interests; and on the expressed opinions of experienced officials and scientific workers.

The authors of the report give their reasons for confining themselves to 'timber' and omitting other forest produce in the following: "We have excluded from our enquiry the wide range of articles frequently described as 'minor forest produce,' including grasses, canes, gums, and tanning materials. We have only referred to the imports into the United Kingdom of manufactured wood, of wood pulp and of cellulose for the purpose of indicating the total demand made by the United Kingdom on the sources of wood supplies. We took some evidence on the import trade in manufactured wood, but found that this raised very large issues, an examination of which would have prevented the production of this report in time for the forthcoming Forestry Conference. We therefore deemed it advisable to confine this Report to the raw material —timber. The timber trade is a very important one, and the Empire resources are extensive and varied."

One of the chief points, perhaps of equal interest and importance, which emerges from the evidence taken by the Committee, is the difference of opinion on the subject of world timber supplies of softwoods which exists between the members of the timber trade and forest authorities "all the world over" as the Committee expresses it—although it is doubtful whether there is such a universal consensus of opinion as this statement would appear to indicate. However, the forest authorities are said to regard the world supplies of softwoods with anxiety, whereas the authors state: "We must, however, record the fact that in the course of our enquiry we have not found this feeling of apprehension shared generally by the members of the timber trade in the United Kingdom. Adequate supplies have always been readily available in the past, and it is possible that the trade has been lulled into a feeling of security for the future which the world position may not warrant. The commercial point of view is that a scarcity of supplies will adjust itself by an increase of prices which will bring within an economic radius fresh forest areas hitherto untouched." Many forest officers would say that the local timber traders have as good knowledge of the local forests' resources as they have themselves; it is at least open to doubt whether the statement in the report that "the outlook is more fully realised by those concerned with organised forest management and conservation" can be accepted without considerable reservations.

Although the examination of forest resources does not fall within the purview of the Committee in the present report, the necessity for systematic investigation of the rate at which the softwood resources of the world are being depleted is strongly urged. It is well known that Canada contains practically the only supply in the British Empire of such materials, and probably the estimates of existing amounts are fairly trustworthy. The remaining resources are chiefly in European countries, and "systematic investigation" into their rate of depletion is not a practical possibility. We have to rely upon published figures—trade and otherwise; and on reports and information with which the officials of these countries courteously supply us.

The second point in the report is of Empire importance, and in it is embodied the entire value of statistics on Empire resources. The authors write: "If the interest of the timber trade and of the general public is to be enlisted for the conservation and development of the Empire forest resources and the lesser known varieties of Empire grown timber are to secure wider utilisation, statements regarding the world and Empire position must be supported by statistics based on precise knowledge and not on information of a general character." This goes to the root of the whole matter.

For the first British Empire Forestry Conference, held in London in 1920, a tabular form was drawn up, it is believed in London, and sent to forest authorities in countries of the British Empire asking for estimates of the total forest resources of these regions, distinguishing areas containing merchantable timber (exploitable forests) from non-merchantable. Some of the forest authorities produced figures for which they accepted no responsibility; others refrained. In Canada, at the Conference held in 1923, the same request was put forward, and in the report here under review the authors state: "Thus it is anticipated that in the autumn of the current year [*i.e.* after the meeting of the Empire Forest Conference in Australia] information on the timber resources of the Empire will be forthcoming more complete than any at present available." This latter is a possibility. But the statistics "will not be based on precise knowledge," which is what the Economic Committee rightly demands. How could they be? When a conservator of forests, in charge of one of the Empire provinces containing extensive tropical and sub-tropical forests, receives the form alluded to above, he sends copies to his several divisional officers. These men may have charge of an area of anything from 500 to 2000 sq. miles of forest (or more), in many cases much of it unknown and unexplored. They have a staff small in size and partially trained. How are they to produce any figures of stocking, either in proportion of species or volume per unit of area? Even the map areas of the forests are perhaps only rough ones. To anyone who has held charge of similar areas, the possibility of obtaining any figures but those based on guess work will be perfectly obvious. Yet a large proportion of the tropical and sub-tropical forests of the British Empire are in this position. Very much stronger trained staffs and opening up of the forests will be necessary before the value of the returns on the timber resources of the Empire are based on "precise knowledge" as against "information of a general character." Outside the Empire there are extensive areas of tropical and sub-tropical forest (in South America, for example) which are as yet under no true forestry management at all.

We are in full agreement with the writers of the report "that it may be found necessary to make arrangements for the systematic collection and revision of World and Empire consumption in relation to supplies." But the primary basis for those preparing reports in London and suggesting work to be carried out, at any rate where forests and forestry are in question, is to remember that the unit of area is the square mile, the type of forest tropical or sub-tropical, the vegetation often dense and difficult to get through,

whilst the topography of the countryside often offers considerable obstacles to easy or rapid travelling. The young British forest officer minds none of those things. But knowledge, a trained staff, plenty of time (which entails much larger staffs), and an adequate equipment are required if the figures obtained for the total forest resources of the Empire (even for merchantable timber) are to be of a practical value. We find no reference to this part of the problem in the report under review.

The suggestion for co-operation amongst the owners of woods in Great Britain for improving their woodlands and in marketing the produce are to the point; also on the important subject of the introduction of new Empire hardwoods on to the home markets. In this latter matter the forest officer is practically powerless. It is a question for the timber merchant, and as the writers of the report rightly say, the introduction of new timbers "involves risk and expense which exporters, with or without Government aid, must be prepared to undertake"; and they add: "We advocate a policy of restraint in regard to the number of varieties of new Empire timbers which are concurrently introduced into the British market."

This report is a valuable piece of work, covers a wide range of outlook in the timber problems of the British Empire, and its perusal may be strongly recommended to all who are in any way interested in timber supplies.

The Four Component System in Peace and War.

DR. F. A. FREETH, of Imperial Chemical Industries, Ltd., honorary lecturer in the theory and practice of heterogeneous equilibria at University College, London, gave his inaugural address on Friday, Mar. 1, on "The Four Component System in Peace and War."

The particular type of four component system with which Dr. Freeth dealt is known as the reciprocal salt pair, or as a double decomposition. One of the latest and best-known examples of this is the conversion saltpetre process, whereby potassium chloride and sodium nitrate are converted into potassium nitrate and sodium chloride. The subject was developed along the lines of Meyerhoffer, one of the pioneers of this field, who published his paper about thirty years ago, but the method of representation used to explain the original arguments was that developed by Prof. Janecke, of the Technical High School, Hanover.

The method of representation takes the form of a cube the base of which represents all the possible mixtures of the salts whilst water is plotted vertically. Considering the base of such a cube only, that is to say, the relative proportions of the salts, such base can be considered as being divided into four areas, each of which represents saturation with respect to one of the four salts under consideration. If by any means a solution can be obtained within an area representing saturation with respect to a particular salt, then generally speaking it is possible to obtain that salt in a pure condition.

The famous reciprocal salt pairs of commerce were then considered, particular attention being paid to the ammonia soda process which was developed in Great Britain by the late Dr. Ludwig Mond. Several other well-known working processes were also discussed, notably the caustification of sodium carbonate by lime giving caustic soda. All these old commercial processes were developed empirically, and it is generally found that current practice corresponds very closely with the optimum conditions predicted by a stringent theoretical treatment.

Reactions of this character played a very important part in the War. Fixed nitrogen is essential for modern explosives, both for propellants and for the high explosives used for bursting charges in shells. Until the War, the main source of fixed nitrogen was Chile nitre; treatment of this nitre with sulphuric acid yields nitric acid, which can be converted into high explosives like tri-nitro-toluene, propellants such as cordite, and by neutralisation with ammonia can be made to yield ammonium nitrate. Germany obviously could not depend indefinitely on the Chile supplies, so the Haber and the Ostwald processes were developed. The Haber process makes ammonia, using coke, air, and water as raw materials; the Ostwald process, by burning ammonia with a limited quantity of oxygen, converts it into nitric acid. After these processes were once developed on a sufficiently large scale, Germany was automatically independent of any outside supplies of fixed nitrogen. Both processes, more especially the Haber process, required very considerable advances in technique.

On the outbreak of war in 1914 it soon became manifest that immense supplies of fixed nitrogen would be required by Great Britain. Even assuming that the productive capacity, making nitric acid on the old lines, would have been sufficient, there was a shortage of toluene for the necessary quantity of T.N.T. had that explosive been exclusively used. It was speedily discovered that T.N.T. could be diluted with no less than four times its weight of ammonium nitrate without impairing the high-explosive properties of the mixture. The supply of ammonium nitrate, therefore, became of vital importance. Lord Moulton, the director of Explosive Supply, was faced with the following dilemma: Should he attempt to erect Haber and Ostwald plants of the necessary size, or should he attempt to make ammonium nitrate by double decomposition, using Chile nitrate as his source of fixed nitrogen? He decided on the latter course, for the very good reason that he considered the enormous calls on technical men of every kind rendered it almost out of the question to develop what was, in Great Britain, an entirely novel process.

Three double decomposition processes were used in the War period, and nearly all of them had been considered as technically impossible after practical trial. These processes were:

(1) The ammonia soda reaction on sodium nitrate giving ammonium nitrate and sodium bicarbonate. (2) Conversion of the waste calcium chloride of the ordinary ammonia soda process into calcium nitrate by double decomposition with sodium nitrate and the subsequent decomposition of the calcium nitrate with ammonium carbonate yielding ammonium nitrate and calcium carbonate. (3) Double decomposition of sulphate of ammonia and sodium nitrate giving ammonium nitrate and sodium sulphate. This latter process, after initial failure, afterwards became successful; it was worked on a very large scale in Great Britain and upon a still larger scale in the United States. All these processes were developed both theoretically and practically in the research laboratories of Messrs. Brunner Mond and Co., Ltd., of which Dr. Freeth was the head.

Finally, Dr. Freeth paid tribute to the extraordinary help which those engaged in developing this process had received from theoretical work of the Dutch school, notably of Prof. Schreinemakers in Leyden, while the germ of all the theories involved goes back to a most distinguished American mathematical philosopher—Willard Gibbs—probably one of the most detached men who ever lived.

Fauna of the Paraguayan Chaco Swamps.

A SERIES of papers on the fauna of the tropical swamps of the Paraguayan Chaco were read at the meeting of the Linnean Society on Jan. 3. Messrs. G. S. Carter and L. C. Beadle, in a preliminary paper, dealt with the relation of the fauna to the physico-chemical conditions of the environment. These swamps cover large areas of the plains to the west of the Paraguay River on the latitude of the southern tropic; those in the neighbourhood of the station of the South American Mission Society at Makthlawaiya (58° 19′ W., 23° 25′ S.) were investigated. They are shallow, frequently dry, and are filled with much aerial vegetation in all parts. During eight months (October 1926–June 1927), observations were made at regular intervals of several characteristics of the water in the swamps. The most striking observations were: (1) The high temperature which the surface-layers of the water were sometimes found to reach (42° C.); (2) the large quantities of phosphates always present (up to 10 mgm. per litre); (3) the low tension of dissolved oxygen, not more than 2-3 c.c. per litre in the surface layers, while below the upper 4-6 in. there was scarcely ever more than 0·2 c.c. per litre during the hot weather. This low oxygen content is believed to be due partly to the poverty of the aquatic flora, partly to the great activity of decay at the high temperature, and partly to the absence of convection currents caused by the cooling of the surface layers at night. The behaviour and distribution of the fauna show that the shortage of dissolved oxygen in the water is the greatest bionomic factor.

Dr. R. Gurney submitted a report on the Branchiopoda of the expedition. Dr. Carter's collections include five species, of which three appear to be undescribed. Four of them are Conchostraca, and include the remarkable *Cyclistheria histopi*, which is found also in Africa, India, Ceylon, and Australia.

Mr. E. Meyrick discussed the Microlepidoptera which were collected. The nature of the region would probably not be very favourable to Microlepidoptera. The number of species in identifiable condition is 32; of these, 2 genera and 22 species are described as new. Of the remainder, 3 are horticultural pests introduced with their food-plants, 1 a widely spread American insect, 2 are found also in the Argentine, and 4 in the Amazon valley. The new species are generally of Guiana and Amazon types.

Messrs. Carter and Beadle described their observations on the habits and development of *Lepidosiren paradoxa*. The subsoil of clay, which occurs everywhere in the parts of the Paraguayan Chaco inhabited by this fish, preserves water in the burrow used in dry weather, thus keeping its skin moist. Oxygen is normally absent from the water surrounding the nest of the *Lepidosiren*, and the manner in which the respiratory needs of the eggs and young larvæ are satisfied is discussed. The normal rhythm of the contraction of the pigment cells of the skin of the larvæ at dusk and their expansion at dawn is preserved for some days when the larvæ are kept in the dark continuously.

Dr. J. Stephenson dealt with the Oligochæta. Oligochæta have been collected from the northern and more remote part of Paraguay only twice previously, and then only in small numbers; hence the present collection contains a large proportion of new species. Limicoline forms are in the majority. A considerable part of the interest of the present collection lies in considerations of geographical distribution.

Dr. W. A. Cunnington reported on the Argulidæ of the expedition, which belong to the genera *Dolops* and *Argulus*. The two species of *Dolops*—*Dolops striata* (Bouvier) and *Dolops geayi* (Bouvier)—are of interest, as certain specimens are larger than any hitherto recorded. The single species of *Argulus* appears to be new to science.

Mr. H. W. Parker discussed the Amphibia and Reptilia which were collected. Dr. Carter's collections contain two tadpoles and a half-grown example of the frog *Ceratophrys lævis* (Budgett). The tadpoles, hitherto undescribed, have mouth-parts of a kind unique amongst the Salientia, and, as their food is exactly similar to that of some other species of *Ceratophrys*, this suggests that *lævis* is not closely genetically related to the other members of the genus in which it is at present included.

University and Educational Intelligence.

CAMBRIDGE.—D. J. Watson, Downing College, has been appointed to the Frank Smart University Studentship in Botany. J. C. P. Miller, Trinity College, has been elected to the Sheepshanks Exhibition.

THE Chadwick Trustees invite applications from British subjects between twenty-five and thirty years of age who are graduates of a British university or of equivalent standing, for two travelling scholarships of £400 each, to enable the holders to travel abroad during one year to study methods adopted in other countries for the prevention of disease and the improvement of the public health. One scholarship will be for sanitary science and the other for municipal engineering. Applications must be sent in before Mar. 25; full particulars may be obtained from the Clerk of the Chadwick Trustees at 204 Abbey House, Westminster, London, S.W.1.

PARENT-TEACHER associations have so grown, says the United States Bureau of Education in the November issue of *School Life*, that they have become one of the outstanding forces in American education. Their members, numbering more than a million and a quarter, are organised under the guidance of the National Congress of Parents and Teachers, founded in 1897, for the promotion of a better understanding between parent and teacher with consequent co-operation between home and school and appreciation on the part of all citizens of their responsibility to the younger generation. The Congress executive operates, with the help of the teacher members, an ambitious scheme of adult education in which it has the powerful backing of the federal Bureau of Education, and last September it promulgated a manifesto urging the supreme importance of universal education for parenthood. In this document, which was published in the October issue of *School Life*, it calls upon universities and colleges to develop special courses in this subject in their teacher training, extension and correspondence study departments, exhorts public librarians to organise special facilities for its study, and State and city school officers to plan for bureaux of parent education. The Bureau of Education is supporting this movement by publishing a series of nine articles by eminent authorities concerning parent-teacher associations in their relation to the children and to the schools of elementary, secondary, and higher grade. The first of these, on the Congress programme of parent education, appears in the November issue of *School Life*. Others will deal with pre-school education, the teacher, the parent and the curriculum, recreation as a necessary part of home life, parents and the sex question, parents and high-school students, parents in higher education, books, and parent education in the home.

Calendar of Patent Records.

March 11, 1835.—A patent was granted to Robert Jupe, upholsterer of London, on Mar. 11, 1835, for an improved expanding table in which the width was enlarged as well as the length, the principle being applicable to round or other shaped tables. The table top was divided into a number of sections which could be caused by suitable mechanism to diverge from the common centre, the spaces thus formed being filled by inserting 'leaves.'

March 12, 1839.—The patent granted to Job Cutler of Birmingham for an improved method of constructing chains for suspension bridges and other purposes, and dated Mar. 12, 1839, is one of the rare cases in which a caveat against the grant of a patent was entered at the Great Seal, the last stage at which a patent could be opposed. The Attorney-General, on the evidence of John Farey, reported against the grant, but the Lord Chancellor overruled the objection and sealed the patent as of the original date.

March 13, 1561.—The patent granted to Philip Cockeram and John Barnes in 1561 for the manufacture of saltpetre affords the first known instance of an official specification or written description in connexion with a patent for an invention, though the delivery of the description was not a condition of the grant. It appears that Queen Elizabeth agreed to pay Gerrard Honricke, a German, the sum of £300 if he would teach certain of her subjects how to make saltpetre as it was made on the continent and would also give an account of the process in writing. The 'specification' was duly delivered to the Secretary's office on or about Mar. 13, 1561. The Queen thereupon granted a patent to Cockeram and Barnes for ten years, and transferred to them the obligation to pay Honricke the stipulated sum.

March 14, 1769.—On Mar. 14, 1769, within a few weeks of James Watt's steam engine patent being sealed, a patent was granted to Francis Moore, draper, of London, which made Dr. Small write to Watt: "Moore has taken out a patent for moving wheel carriages by steam. This comes of thy delays. . . . At this moment, how I could scold thee for negligence." Watt was not, however, perturbed by the information, and replied that Moore could not make a steam carriage without using his (Watt's) patent, and that if he did use it, Watt would easily be able to stop him. No specification was enrolled with Moore's patent, and the only evidence of his improved carriage shows a horse-drawn vehicle having very large diameter wheels.

March 15, 1784.—The argand burner, the first notable improvement on the primitive oil lamp, was invented by Amié Argand, a French chemist living in London, and patented by him in England on Mar. 15, 1784. Argand was anticipated in France by Ambroise Lange, who had seen the invention in London and gave it to the Paris Academy as his own. Later, the two joined forces, and a French patent was granted in the two names, but this with other similar privileges was suppressed by the Revolution and the invention thrown open to the public. Argand's reason gave way under the series of misfortunes and he returned to England to devote the remainder of his life to an attempt to discover the elixir of life.

March 16, 1744.—A patent was granted to Samuel Sutton on Mar. 16, 1744, for a method of extracting the foul air from the holds and living quarters of ships through pipes heated by the ordinary cooking and other furnaces of the ship. Sutton himself tells that he experienced great difficulty in getting the invention adopted by the Admiralty, but eventually it was installed in a large number of H.M. ships.

Societies and Academies.

LONDON.

Royal Meteorological Society, Feb. 20.—L. H G. Dines: The Baker automatic release for dropping the meteorograph from a registering balloon at a predetermined height.—C. K. M. Douglas: Some aspects of surfaces of discontinuity. The more important pressure changes on weather maps are due mainly to large-scale horizontal movements at levels round about the base of the stratosphere, considered in conjunction with movements at lower levels. The changing pressure fields cause converging and diverging movements, which influence fronts and produce inversions where the air is subsiding.—E. Kidson and H. M. Treloar: The rate of ascent of pilot balloons at Melbourne. Atmospheric turbulence is the most important cause of departures from the normal rate of ascent. The greater the turbulence the greater is the mean height. The turbulence due to surface-heating of the air is more effective than wind turbulence in increasing the rate of ascent in the lowest layers. The heat turbulence is effective chiefly near the surface and in light winds. The rate of ascent is less in stable than in unstable air under the same conditions as to turbulence.

Physical Society, Feb. 22.—L. F. Stanley: The construction and calibration of a sensitive form of Pirani gauge for the measurement of high vacua. The gauge consists of a manometer and a compensator, the one identical with the other, placed in the opposite arms of a Callendar-Griffiths bridge; each consists, essentially, of a loop of 10 cm. of platinum wire, of 0·001 inch diameter, together with a compensating loop of 2 cm. of the same wire. The symmetry of the circuit makes errors due to thermoelectric effects very small. The gauge follows variations of pressure with considerable rapidity, and its range of measurement is from 2×10^{-3} mm. to 4×10^{-6} mm. approximately.—Charles H. Lees: The free periods of a composite elastic column or composite stretched wire. The free periods of the longitudinal oscillations are determined when both ends of the column are nodes, when one is an antinode, and when both are antinodes. A graphical method of dealing with the problems is developed.—Allan Ferguson and J. A. Hakes: A capillary tube method for the simultaneous determination of surface tension and of density. A capillary tube of radius r is immersed vertically to a depth h_1 in a liquid of density ρ_1. Tube pressure $g\rho h$ required to force the meniscus down to the lower end of the capillary and to hold it there is measured. If h_1 and consequently h be varied, a plot of h against $(h_1 - r/3)$ gives a straight line, from slope and intercept of which the surface tension and the density of the liquid may be inferred.

CAMBRIDGE.

Philosophical Society, Jan. 28.—Sir Ernest Rutherford and J. Chadwick: Energy relations in artificial disintegration. Experiments on the disintegration of aluminium indicate that the change of energy is not the same for each nucleus, but that it may vary by so much as 5×10^6 electron-volts. Hence, either the mass of the aluminium nucleus or that of the nucleus formed in the disintegration may vary by nearly 0·006 mass units.—R. H. Fowler: An analogy for beams of particles of a reciprocal optical theorem due to Helmholtz.—D. R. Hartree: The distribution of charge and current in an atom with several electrons obeying Dirac's equations. The approximation is made that each electron can be treated as in a stationary state in the field of the nucleus and the

remaining electrons, and further that this field is spherically symmetrical. An exact formula for the magnetic moment corresponding to a solution of Dirac's equation in a central field is given, and leads to Landé's g-formula when 'relativity effects' are neglected.—**N. Feather** and **R. R. Nimmo**: The distribution of range of the α-particles from radium C′ and thorium C′. Distribution curves relative to 2134 α-particles from thorium C′ and 729 from radium C′ showed that many more had ranges between 6 cm. and 8 cm. of standard air than was expected, and that the excess of short range particles was much greater in the former case than in the latter, where the results agreed satisfactorily with those of Briggs, obtained by the magnetic deflexion method.—**R. M. Gabriel**: Some further results concerning the integrals of moduli of regular functions along curves of certain types.

PARIS.

Academy of Sciences, Jan. 28.—**V. Grignard** and **Tchéoufaki**: The α-diacetylene hydrocarbons. Hydrocarbons of the type $RC \equiv C - C \equiv CR$ can be obtained in good yields by the action of iodine in ether solution upon alkyl magnesium compounds, provided that the conditions laid down are closely followed. In the fatty series, dipentine, dihexine, and diheptine have been prepared by this method, and several aromatic hydrocarbons of the same type are also described. Phenyltriacetylene, $C_6H_5 - C \equiv C - C \equiv C - C \equiv CH$, has also been prepared and its properties are given.—**Serge Bernstein**: Orthogonal polynomials.—**Auguste Lumière**, **Mme. R. H. Grange**, and **R. Malaval**: The pH of arterial blood and of venous blood. Measurements by the electrometric method give pH values of 7·85 for arterial blood and 7·50 for venous blood. The main cause of the variations appears to be the amount of carbon dioxide present.—Georges Birkhoff was elected *correspondant* for the Section of Geometry in the place of the late Ivar Fredholm, and Adrien de Gerlache *correspondant* for the Section of Geography and Navigation in the place of the late Sir Philip Watts.—**Maurice Fréchet**: The distance of two contingent variables.—**Lucien Féraud**: Bundles of conjugated networks.—**Frank Loebell**: The generalisation of a theorem of H. A. Schwarz.—**Nicolas Cioranesco**: The problem of Dirichlet for systems of equations of the elliptic type and the extension of a functional relation of M. Hadamard.—**A. Gay**: The movement of a cylinder in a viscous fluid.—**Jules Baillaud**: The determination of the galactic pole from the data of the selected areas.—**L. d'Azambuja**: The use of the spectro-heliograph for the determination of the level of the vapours of the reversing layer or lower portion of the solar atmosphere.—**H. Pélabon**: Rectification by purely metallic bad contacts. A description of the phenomena observed using as rectifier two similar steel cylinders separated by a thin layer of lycopodium powder or cork dust.—**Henri Gutton**: The effect of a magnetic field on the resonance phenomena in ionised gases.—**P. Salet**: The constancy of the velocity of light. Arguments against the application of the ballistic theory to the explanation of the changes in the intensity of light in certain stars.—**E. Darmois**: The rotatory power of the tartrates of certain organic bases: contribution to the study of strong electrolytes.—**A. Smits**: The allotropic modifications of phosphorus. Remarks supplementing the author's communication of Nov. 29 last, and criticism of the work of Nicolaïeff on the same subject.—**W. Swietoslawski**: A boiling-point apparatus designed for researches under high pressures. A modification of an apparatus previously described capable of being used under pressures up to 25 atmospheres.—**A. Zmaczynski**: A new modification of a boiling-point apparatus used for high pressures.—**M. Prettre** and **P. Laffitte**: The temperature of ignition of combustible gaseous mixtures. The results given in an earlier paper on the temperatures of ignition of mixtures of air and hydrogen are much lower than those given by other workers, and this is attributed to the lower initial pressure adopted. The present paper gives the result of the influence of the preliminary vacuum on the temperature of ignition.—**Mlle. Germaine Marchal**: The action of silica, alumina, and of kaolin on barium sulphate.—**Mlle. Jeanne Lévy** and **A. Tabart**: The relative affinity capacities of various radicals on the course of the isomerisation of the trisubstituted ethylene oxides.—**P. Fallot**: The relations of the sub-Betic with the Betic in the Sierras Tercia and Espuña.—**H. Pollet**: Atmospheric electricity in the course of the sand storms of the north of China. The electric charge on each dust particle is of the order of 100 times the elementary charge of an ion.—**P. L. Violle** and **A. Giberton**: The neutralisation of the oligodynamic power of copper by solutions of electrolytes. Application to mineral waters.—**Georges Truffaut** and **G. Thurneyssen**: The influence of artificial light on the growth of the higher plants. A description of the lighting arrangements by means of which normal beans and strawberries have been produced. The microscopic examination of the leaves of the strawberry plants cultivated in artificial light showed that they were normally provided with chlorophyll and that their palisade tissues exactly resembled the normal palisade tissue of plants raised in daylight.—**Charles Pontillon**: The existence of resins in *Sterigmatocystis nigra*.—**J. Manquené**: The alluvial formations of western Algeria after the inundations of 1927.—**Lucien Daniel**: The accentuation and persistence of symbiotic adaptations in the Jerusalem artichoke grafted on the annual sunflower.—**Mlle. G. Fuchs**, **J. Régnier**, **D. Santenoise**, and **P. Vare**: A thyroid hormone regulating the cerebral excitability.—**Paul Wintrebert**: The liquefaction of the internal sheath of the egg in the urodelan Amphibia.—**René Fabre** and **Henri Simonnet**: The comparative study of the value of the biological test and the physical test of irradiated ergosterol. It appears to be premature to attribute to the biologically active product a definite absorption spectrum.—**R. Fosse** and **A. Brunel**: A new ferment. This ferment, named allantoinase, is found in various leguminous seeds and is characterised by its power of hydrolysing allantoin to allantoic acid.

ROME.

Royal National Academy of the Lincei, Nov. 11.—**T. Levi-Cività**: The motion of a body of variable mass.—**G. Fubini**: Further considerations on the transformations of Laplace, Lévy, and Moutard for hypersurfaces.—**G. Abetti**: Anomalies of gravity and deviations of the vertical determinated by the De Filippi expedition in Central Asia (1913–14). The results obtained by this expedition, taken in conjunction with those of the Survey of India to the south of the Himalayas and those of the Russian Geodetic Service in Turkestan and Pamir, show that on these mountain chains the gravitation constant is usually in excess. To the south and to the north it is, however, usually deficient, this being an indication of the probable equality of the conditions of compensation or non-compensation in the Indo-Ganges plain and in the plains of Turkestan.—**F. Vercelli**: Experimental considerations concerning certain geo-electric methods.—**L. Rolla** and **L. Mazza**: Concerning thallium photoelectric cells. The procedure recently described by Majorana and Todesco for the preparation of thallium photoelectric cells

was published by Rolla in 1927 and has been patented. Such cells have been successfully used by the Italian military authorities.—**G. Ascoli**: The singularity of the solution in Dirichlet's problem. A sufficient condition, not of purely geometrical character, but of ready applicability, is given for the validity of the theorem of singularity of the solution in Dirichlet's problem.—**F. Sbrana**: A remarkable group of functional operators. Some of the essential results are given of the author's recent investigations on the calculus of functional operators $f(\Delta)$ with $\Delta = \frac{\partial}{\partial t}$ and t variable and real. This method of calculus, known as operational or symbolic calculus, is finding increasing application in the solution of numerous mathematical physical problems of industrial importance or inherent to modern atomic physics.—**G. Aliprandi**: Determination of the principal triplet (terna)—of Vitali—of a generic surface, considered as an autopolar terna of the geodetic cone.—**A. M. Bedarida**: The algebraic bodies of Galois.—**G. Scorza Dragoni**: Concerning a differential equation.—**M Lelli**: Bernouilli's theorem for homogeneous viscous liquids.—**R. Calapso**: A new transformation of isothermal surfaces.—**E. Čech**: Observations on the quadrics of Darboux.—**G. Sannia**: New definitions of the canonical pencil.—**M. Maggini**: Interferometric measurement of the effective wave-length of double stars and its variation with the zenithal distance. The interferometer is able to replace not only the micrometer where this is ineffective, but also the diffraction grating in the measurement of wave-length, and the photometer in the measurement of extinction.—**E. Adinolfi**: The influence of X-rays on the structural conditions of bismuth and tellurium (3). When absorbed by bismuth during its solidification, X-rays modify the structure of the metal, which exhibits a diminished Hall's coefficient and becomes electropositive towards ordinary solidified bismuth. Under similar treatment, tellurium also assumes a lower Hall's coefficient, but is rendered electronegative with respect to ordinary tellurium. When solidified rapidly from the molten state, both of these elements increase in hardness and acquire an increased specific heat, the latter change occurring also in the case of solidification under the influence of X-rays.—**O. Occhialini**: Low voltage sparks as spectroscopic sources. The procedure to be adopted to obtain these sparks, which are formed at a voltage of 220, is described.—**P. Agostini**: Heats of formation of double cadmium potassium chlorides. The heats of formation of the compounds, KCl, $CdCl_2$, and 4KCl, $CdCl_2$, are found to be $+3{\cdot}65$ ($3{\cdot}73$) Cal. and $+0{\cdot}989$ Cal. respectively.—**G. Bargellini** and **Lydia Monti**: α-Phenylcoumarins. Various α-phenylcoumarins have been prepared by the condensation of aromatic o-hydroxyaldehydes with substituted phenylacetic acids.—**G. Bargellini** and **P. Leone**: 3 : 5 - Dichlorophenetidine. The best conditions for preparing this compound by passing hydrogen chloride through an alcoholic solution of nitrosophenol (Jaeger's method) are described, together with several of its derivatives.—**G. A. Barbieri**: New method for the volumetric determination of cobalt. In the green liquids resulting from the decomposition of cobaltinitrites by hot sodium hydrogen carbonate solution, all the nitro groups of the cobaltinitrous complex are present as alkali nitrate, whilst the tervalent cobalt forms part of a cobalticarbonic complex, to which the green colour is due. If the liquid is introduced into permanganate solution acidified with sulphuric acid, the nitrous acid is oxidised quantitatively in the cold to nitric acid and the tervalent cobalt is reduced to the bivalent form, so that eleven equivalents of oxygen are consumed for each molecule of the original cobaltinitrite. These reactions serve as a basis for the volumetric determination of cobaltinitrites and hence of the two elements which can be separated quantitatively as cobaltinitrites, namely, potassium and cobalt.—**G. R. Levi**: Further investigations on catalysis with metals of the platinum group. The catalytic decomposition of hydrogen peroxide by platinum is greatly influenced by the presence of other metals of the group. Iridium and, to a less extent, rhodium depress the catalysis, and palladium seems to act similarly to iridium. Possibly owing to a positive influence of the metal and a negative influence of the oxide, ruthenium is almost without effect on the catalysis. Although the catalytic formation of sulphur trioxide is influenced only slightly and negatively by osmium, the decomposition of the peroxide is very markedly increased in the presence of this metal.—**G. Piccardi**: The Rontgen levels of the rare earths and the derivations from Moseley's law.—**A. Barchiesi**: Ponderal and histophysiological investigations on guinea-pigs and rabbits subjected to injections of lipoid mixtures. Injection of lipoid mixtures affects all the organs and tissues examined and modifies the whole organic metabolism. The results seem to support Serono's assumption that, possibly owing to their special chemical character, lipoids form biological catalysts which induce many complex reactions.—**G. Brunelli**: Biophysical nature of the pitted erosion of the arenaceous rocks of the Tyrrhenian coast. Observations made at Cape Linaro show that the perforation of the rocks is due initially to small shells of *Littorina punctata* and *L. neritoides*, which attack the rock at the points of least resistance. Afterwards the action of the waves affects further destruction of the rock in the perforations initiated by the molluscs, so that the degradation is of mixed, biophysical character. In certain cases *Patella* also plays a part in this phenomenon.—**S. Ranzi**: Relations between organogenetic and histogenetic processes. (Investigations on experimental morphology in the cephalopods.) Considerations of phenomena relating to the development of the embryos of cephalopods indicate that, up to a certain point, histogenetic processes are independent of organogenetic processes. This general principle is in complete accordance with many data obtained from experiments on the culture of the tissues of vertebrates, these showing that, for varying but usually short periods, the cells may retain their differentiation.—**Aldo Spirito**: Regulative processes of the encephalic region of the embryos of *Anura*.—**T. Terni**: Regeneration and super-regeneration of tissue and of organ in the tail of adult urodeles.

SYDNEY.

Linnean Society of New South Wales, Nov. 28.—**G. D. Osborne**: (1) The Carboniferous rocks between Glennies Creek and Muscle Creek, Hunter River District, N.S.W. Comprise representatives of the Burindi Series, a marine series of Lower Carboniferous age, and the Kuttung Series, of Middle to Upper Carboniferous age; the latter are at least 8000 feet in thickness, and have been subdivided into the volcanic and glacial stages. The late Palæozoic diastrophism produced a basin-structure and associated broad folding. Connected with this movement there developed a series of normal faults, one of which—the Brushy Hill Fault—is of great importance. Separating the Carboniferous rocks from the Permian strata is a great fault—the Hunter Overthrust, which is of later date than the normal faults.—(2) The Carboniferous rocks of the Muswellbrook-Scone District, with special reference to their structural relations. This area described

is to the north of that discussed above and has similar stratigraphical and tectonic features. In the north-west is the important Wingen fault, which cuts across the Hunter Overthrust. It then strikes into the Carboniferous rocks, and is marked by a wonderful shatter-zone, up to five chains in width.—**J. R. Malloch**: Notes on Australian Diptera. No. 18. An alphabetical catalogue of genera and species of Tachinidæ. —**A. B. Walkom**: Notes on some additions to the *Glossopteris* flora in New South Wales. Descriptions of (1) a collection of small *Glossopteris* leaves which belonged to the late John Mitchell, (2) two terminal shoots (from the collection of the Geological Survey of New South Wales) which may possibly represent part of the plant which bore *Glossopteris* fronds, and (3) a collection of seeds belonging to Mr. T. H. Pincombe. Some of the latter resemble very closely seeds described from Upper Carboniferous and Permian rocks in Europe.—**Frank A. Craft**: The physiography of the Wollondilly River Basin. To the west of the Illawarra coast there is an area of plateau country forming the basins of the Wollondilly and Nepean Rivers. Behind the coastal scarp over an extensive area this plateau has an elevation of 2000-2500 feet, and is drained by the Eastern Wollondilly system and the Lower Shoalhaven. This gives place in the west to a higher tableland, which rises from south to north. The plateau as a whole presents a mature surface which is being cut up by stream erosion most markedly in the north.

VIENNA.

Academy of Sciences, Nov. 29.—**E. Smreker**: Anastomoses between the dentine channels and cement corpuscles in the chamois.—**K. Menger**: The semi-constancy of arc length.—**O. Wettstein**: Amphibia and reptilia from Palestine and Syria.—**F. Heritsch**: Corals from the Carboniferous of the Yeitsch in Upper Styria.—**H. Hahn**: Continuous extension images.—**F. Dehmer**: Irreducible continua.—**J. B. Niederl** and **R. Casty**: New condensations of ketones with phenols. (2) Further cresol-phorones.

Dec. 6.—**L. Moser** and **O. Brandl**: The determination and separation of rare metals from other metals. (13) Re-examination of the gravimetric analysis of vanadium and two new methods for its determination. There are several lead vanadates; under certain conditions first lead hexa-vanadate and then lead pyro-vanadate is formed. Vanadic acid can be completely precipitated with mercury nitrate again under certain conditions.—**L. Moser** and **F. List**: (14) Separation of beryllium from the metals of the alkaline earths and from the metals of the ammonium sulphide and arsenic groups. One way is by forming difficultly soluble metal tannic acid adsorption complexes, the other by hydrolysis of the beryllium ion by ammonium nitrite and methyl alcohol.—**E. Spath** and **N. Polgar**. A synthesis of non-hydrated iso-quinoline derivatives.—**A. Skrabal**: The varieties of unstable intermediate substances in chemical kinetics. The intermediates during the main period of the reaction may be in equilibrium with the initial or with the final substances.—**F. Hölzl**: Buff's substance and Bunsen's salt. Salts of tetrabasic hexa-cyano-ferric acid with alcohol as base.—**W. L. Ayres**: Generalisations of Jordan's continua.—**G. Bergmann**: Axioms in elementary geometry.—**B. Finzi**: Ants from Greece and the Ægean islands.—**D. W. Adensamer** and **F. Kaufel**: Land and fresh-water mollusca from Greece and the islands of the Ægean.—**H. Strouhal**: Land isopods from Greece and the islands of the Ægean.—**H. Preisner**: Rhyncota from Greece and the islands of the Ægean.

Dec. 13.—**V. Pietschmann**: New species of fish from the Pacific Ocean.—**F. M. Exner**: Dune studies in the Courland sandhill tongue, with an appendix on river-meanders, clouds, and cyclones arising from friction eddies. Sand waves are explained by horizontal eddies. Small sand waves move rapidly, larger waves slowly.—**F. Sigmund** and **R. Uchann**: The catalytic splitting off of alcohol from acetals (preparation of unsaturated ethers). By using a clay catalyser at 200°-250°; nickel not essential.—**C. Doelter**: Reactions with blue rock-salt.—**C. Zawisch-Ossenitz**: The development of the human femur.—**W. Figdor**: Cone-shaped leaves and the asexual multiplication of *Bryophyllum proliferum*.—**K. Fritsch**: Observations on flower-visiting insects in Styria, 1908.—**G. Ortner** and **G. Stetter**: The use of electronic valve amplifiers for counting corpuscular rays.—**E. Guth**: Systems of linear partial differential equations of the first order, compatible with a given metric, especially Maxwell's equations and Dirac's equations for the electron.—**F. Urbach**: The form of the absorption and emission bands in solids.—**A. Zinke, W. Hirsch**, and **E. Brozek**: Researches on perylene and its derivatives (19).—**K. Funke, F. Kirchmayr**, and **H. Wolf**. Researches on perylene and its derivatives (20).—**A. Pongratz** and **E. Pochmuller**: Researches on perylene and its derivatives (21).

Official Publications Received.

BRITISH.

Report of the Commission on Closer Union of the Dependencies in Eastern and Central Africa (Cmd. 3234.) Pp. 354+5 maps. (London: H.M. Stationery Office.) 6s net.

Colonial Veterinary Service. Report of a Committee appointed by the Secretary of State for the Colonies. (Cmd. 3261.) Pp 44. (London: H M. Stationery Office.) 9*d.* net.

The Scientific Proceedings of the Royal Dublin Society Vol. 19 (N.S.), No. 16: The Integration of Light by Photo-Electrolysis. By Dr. W R. G. Atkins and Dr. H. H. Poole Pp. 159-164 6*d.* Vol 19 (N S), No 17: A Note on Gas Analysis By James T Donnelly, C. Hamilton Foott and J Reilly. Pp. 165-172. 6*d.* (Dublin. Hodges, Figgis and Co., London. Williams and Norgate, Ltd.)

The Proceedings and Transactions of the Nova Scotian Institute of Science, Halifax, Nova Scotia Vol 17, Part 2, Session 1927–1928. Pp xi-xix+40+iii. (Halifax, N S.) 50 cents

International Federation of University Women Bulletin No. 10: Report of the Twelfth Council Meeting, Madrid, September 1928 Pp 103. (London)

Air Ministry. Aeronautical Research Committee: Reports and Memoranda. No. 1178 (Ae. 342): The Change in Airscrew Characteristics with Height. By A. E. Woodward Nutt. (T. 2594 and a, revised) Pp. 10+3 plates 9*d.* net. No. 1175 (Ae 339): An Analysis of a Rectangular Monoplane with Hinged Tips By S. B Gates. (T. 2578) Pp. 10+3 plates. 1*s.* net. (London: H.M. Stationery Office)

Proceedings of the Fifteenth Indian Science Congress, Calcutta 1928 (Third Circuit). Pp. xxv+420. (Calcutta: Asiatic Society of Bengal.)

Transactions and Proceedings of the New Zealand Institute. Vol. 59, Part 3, September 1928. Pp iv+429-661+77 plates. (Wellington, N Z.)

Government of India Meteorological Department. Magnetic, Meteorological and Seismographic Observations made at the Government Observatories, Bombay and Alibag, in the Year 1923, under the Direction of Dr. S K Banerji. Pp. ii+72+5 plates (Calcutta Government of India Central Publication Branch.) 8.8 rupees, 14*s.* 3*d.*

The Scientific Proceedings of the Royal Dublin Society. Vol. 19 (N S), No. 15 William Higgins, a Pioneer of the Atomic Theory. By Dr. J Reilly and D. T. MacSweeney. Pp. 139-157. (Dublin Hodges, Figgis and Co.; London: Williams and Norgate, Ltd) 1*s.*

Board of Education. Educational Pamphlets, No 32 The Admiralty Method of Training Dockyard Apprentices Revised edition Pp. 19 (London: H.M. Stationery Office) 2*d.* net

Madras Fisheries Department Fish Statistics for 1925-26. (Supplement to the Administration Report for 1926-27.) Edited by Dr. B. Sundara Raj. (Report No 2 of 1928, Madras Fisheries Bulletin, Vol. 22) Pp. 76 (Madras Government Press) 14 annas.

Transactions of the Institution of Chemical Engineers. Vol 5, 1927. Pp. 230. (London.)

FOREIGN.

Carnegie Institution of Washington: Eugenics Record Office Bulletin No 26: Birth and Death Rates of the Feeble Minded. By Charles V. Green. Pp. 34 (Cold Spring Harbor, L I)

Collection des travaux chimiques de Tchecoslovaquie. Redigee et publiée par E Votoček et J. Heyrovský sous le *patronage* de la Regia Societas Scientiarum Bohemica Annee 1, No 1, Janvier. Pp 64. (Prague.)

Annalen v/d Bosscha-Sterrenwacht, Lembang (Java). Vol 2, 1ste Gedeelte. Die sudliche Milchstrasse. Von A. Pannekoek Pp. A73+6 Tafeln. (Amsterdam: Universiteit)

Pubblicazioni della Università Cattolica del Sacro Cuore Serie ottava, Statistica, Vol. 3. Contributi del Laboratorio di Statistica, Serie Prima. Pp. vii+436. (Milano: Società Editrice "Vita e Pensiero.") 50 lire

Denkschriften der Schweizerischen Naturforschenden Gesellschaft (Mémoires de la Société Helvétique des Sciences naturelles). Band 64, Abh 2: Nouveau Catalogue des moules d'échinides fossiles du Musée d'Histoire Naturelle de Neuchâtel. Exécutés sous la direction de L. Agassiz et E Desor par J. Lambert et A. Jeannet. Pp. ii+83-233+2 planches Band 64, Abh. 3: Zur Frage von der prähistorischen Besiedelung von Amerika mit allgemeinen Betrachtungen über die Stufenfolge der Steinzeit Von Paul Sarasin. Pp. 235-273+3 Tafeln. (Zurich: Gebrüder Fretz A.-G.)

Report of the Secretary of the Smithsonian Institution for the Year ending June 30, 1928. (Publication 2978.) Pp. vi+147. (Washington, D C. Government Printing Office)

Journal of the Faculty of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol 25, Part 1: Dritter Beitrag zur Ichneumoniden-Fauna Japans. Von Toichi Uchida. Pp. 115+3 Tafeln. Vol. 25, Part 2: The Chemical Studies on the Denaturation of Proteins. First Report, by Tetsutaro Tadokoro and Katsuji Yoshimura, Second Report, by Tetsutaro Tadokoro and Shukichi Watanabe. Pp. 117-149. (Tokyo Maruzen Co, Ltd)

Japanese Journal of Mathematics: Transactions and Abstracts. Vol. 5, No 3, December. Pp. 211-267. (Tokyo: National Research Council of Japan)

Bulletin of the American Museum of Natural History. Vol. 58, Art. 3: The Nesting Habits of Wagler's Oropendola (Zarhynchus Wagleri) on Barro Colorado Island By Frank M Chapman. Pp. 123-166+8 plates. Vol. 58, Art. 4: Diptera of the American Museum Congo Expedition. By C. H. Curran. Pp. 167-187. (New York.)

Proceedings of the American Philosophical Society held at Philadelphia for promoting Useful Knowledge. Vol. 67, No. 3. Pp. 199-318. (Philadelphia)

Department of Commerce U S. Coast and Geodetic Survey. Terrestrial Magnetism. Serial No 423: Results of Magnetic Observations made by the United States Coast and Geodetic Survey in 1927. By Daniel L. Hazard. Pp. 22. (Washington, D.C.: Government Printing Office.) 5 cents

State of Connecticut. Public Document No. 24: Fifty-first Report of the Connecticut Agricultural Experiment Station, New Haven, Conn, for the Year 1927. Pp xi+821+xxvi. (New Haven, Conn)

Annual Report of the Director, United States Coast and Geodetic Survey to the Secretary of Commerce for the Fiscal Year ended June 30, 1928. Pp. iv+47+17 plates (Washington, D C. Government Printing Office.) 75 cents.

Contributions from the Jefferson Physical Laboratory and from the Cruft High-Tension Electrical Laboratory of Harvard University for the Years 1926 and 1927. Vol. 19. (Cambridge, Mass)

CATALOGUES.

Industrial Electric Furnaces with Automatic Temperature Control. Pp 12. (London. Wild-Barfield Electric Furnaces, Ltd)

Professor Coker's Photo-elastic Apparatus for determining the Distribution of Stress in Structural and Machine Members. Pp. 28. (London: Adam Hilger, Ltd.)

The Case-Hardening of Special Steels by Nitrogen. Pp. 31. (Sheffield: Nitralloy, Ltd)

Laboratory Fittings for all Classes of Scientific Research (List F.) Pp. 16. Electrically Heated Laboratory Apparatus. (Pamphlet No. 231E.) Pp. 16. Comprehensive List of Scientific Text Books. Pp. 12. (London: A Gallenkamp and Co., Ltd)

Diary of Societies.

FRIDAY, MARCH 8.

ANDERSONIAN CHEMICAL SOCIETY (at Royal Technical College, Glasgow), at 3.15.—W. H. Nuttall: Rubber and its Commercial Applications

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4 30.—W. H. Moreland: The Indian Peasant in History

ROYAL ASTRONOMICAL SOCIETY, at 5—Prof. S. Chapman: Solar Streams of Corpuscles: their Geometry, Absorption of Light, and Penetration. —N. Goryatscheff: Occultations of Stars by the Moon, observed at the Tomsk University Observatory during the Year 1928.—Prof. S. Chapman and V. C. A. Ferraro: The Electrical State of Solar Streams.—Y. Ohman: Astronomical Consequences of the Polarisation of Fluorescence.—W. H. McCrea: The Hydrogen Chromosphere.—C. L. Janssen: Provisional Elements of the Binary System β. G C. 12307.

IMPERIAL COLLEGE CHEMICAL SOCIETY (in Main Chemistry Lecture Theatre, Royal College of Science), at 5.—Dr. N. V. Sidgwick: Chemical Linkage

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section) (Clinical Meeting, at University College Hospital), at 5.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Dr. E. Griffiths and J. H. Awbery: The Dependence of the Mobility of Ions in Air on the Relative Humidity—Prof A M. Tyndall: Some Unsolved Problems relating to the Mobility of Gaseous Ions—followed by a General Discussion on the Mobility of Ions.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration on the Anatomy and Pathology of "Diverticulitis."

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5 30.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (Annual Meeting) (at Liverpool University), at 6.—L. O. Newton. Boiler Feed Water.

MALACOLOGICAL SOCIETY OF LONDON (in Zoological Department, University College), at 6.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. A. Hall: Bromide Papers.

MANCHESTER ASSOCIATION OF ENGINEERS (at Engineers' Club, Manchester), at 7 15.—F. B. Holt: Improvements in Driving Textile Mills.

BLACKBURN TEXTILE SOCIETY (at Blackburn Technical College), at 7.30.—J. H Place: Dobbies.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—S. H. Hole: Road Transport (Chairman's Address).

LEICESTER LITERARY AND PHILOSOPHICAL SOCIETY (jointly with Leicester Association of Engineers) (at Secular Hall, Leicester), at 7.30.—Dr. J. Newton Friend: Science in Antiquity.

INSTITUTE OF METALS (Sheffield Local Section) (at Sheffield University) at 7 30.—W. S. Gifford: Progress in Electric Furnaces.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Milton Hall, Manchester), at 7.30—S. T. Kinsman: The Fastness to Light of Lake Colours.

TEXTILE INSTITUTE (Lancashire Section) (at Manchester), at 7.30.—L G. Lawrie. The Microscopical Investigation of Textile Fibres and Fabrics.

INSTITUTE OF TRANSPORT (Newcastle-upon-Tyne and District Section) (at Y.M C A. Hall, Newcastle-upon-Tyne), at 7.30.—E. McClelland: Some Aspects of Selling Rail Travel

KEIGHLEY ASSOCIATION OF ENGINEERS (at Keighley), at 8.—A. G. Springfield: Centrifugal Castings.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9—Prof. T. F. Tout: The Place of Women in Later Medieval Civilisation.

SATURDAY, MARCH 9.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Yorkshire District) (at Town Hall, Sheffield), at 3—W J. Hadfield. The Local Government Act and the Municipal Engineer.

BRITISH PSYCHOLOGICAL SOCIETY (General Meeting) (at Royal Anthropological Institute), at 3.—Prof T H. Pear and Miss Edna M. Henshaw. Some Subtler Skills: Conditions for Improvement in Manual Dexterity.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3—Sir Ernest Rutherford. Molecular Motions in Rarefied Gases (II.)

MONDAY, MARCH 11.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in Cavendish Laboratory), at 4.30.—N. F. Mott: Quantum Theory of Electronic Scattering in Helium.—H M. Cave: Note on the Number of High Velocity β-rays—J. L. Hamshere: The Mobility Distribution and Rate of Formation of Negative Ions in Air—W. Georgeson Thermionic Emission through Double Layers.—*Papers to be communicated by title only:*—Dr C. F. Sharman. Secondary Electron Emission from Solid Metal Surfaces. —J. G Semple: On Certain Loci of Three Dimensions, Representable on Ordinary Space by Means of Cubic Surfaces, and the Cremona Transformations for Ordinary Space obtained by Projection of such Loci—G de B Robinson. A Geometrical Study of the Alternating and Symmetric Groups—G Redington The Effect of the Duration of Light upon the Growth and Development of the Plant.—Prof. F. E Fritsch Evolutionary Sequence and Affinities among Protophyta.—M. Robertson: Life Cycles in the Protozoa

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Rear-Admiral H P. Douglas: Echo Sounding.

ROYAL SOCIETY OF MEDICINE (War Section), at 5.—Surg-Comdr. H. Hill: Post-encephalitis and its Problems in the Service.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—C. E. Shattock: Demonstration on Specimens illustrating Diseases of the Kidneys.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—Norman Angell. Teaching Economics by Visual Demonstration

TEXTILE INSTITUTE (London Section) (at Clothworkers' Hall), at 6.—Dr. W. Gibson: Research Work as an Aid in the Sale of Linen Products.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Centre) (at Queen's Hotel, Birmingham), at 7 K. Thomas: Some Investigations into the Performance of Tubular Radiators for Motor Vehicles.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7—Ll. B. Atkinson: How Electricity does Things (Faraday Lecture)

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (Associate Members' and Graduates' Branch) (at Borough Polytechnic), at 7—J. H. Bryant: Sprinklers.

SOCIETY OF CHEMICAL INDUSTRY (Yorkshire Section) (at Hotel Metropole, Leeds), at 7 15.—Prof. C. H. Desch: The Nature of Hardness.—H O'Neill The Hardness of Metals.

CERAMIC SOCIETY (at Stoke-on-Trent), at 7 30—F. H Rogers: Factory Floors

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30. Open Discussion.

MEDICAL SOCIETY OF LONDON (at 11 Chandos Street, W.), at 8 30.—Dr. R. Miller and Dr. W. G. Wyllie: Chronic Dyspepsias of Children over the Age of Infancy.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Cardiff).

TUESDAY, MARCH 12.

ROYAL SOCIETY OF MEDICINE (Psychiatry Section) (Clinical Meeting, at Maudsley Hospital), at 4.30.

ROYAL SOCIETY OF MEDICINE (Therapeutics Section), at 5.—Dr G. Lander and Dr C. F. Harris: Treatment of Chronic Tetany with Steatorrhœa in Adults.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Prof. E. B. Verney: Polyuria (II.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5 15.—Dr. S. W. Kemp: Antarctic Whaling Expeditions (I)

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5 30

INSTITUTE OF MARINE ENGINEERS, at 6 30.—Dr. E. V. Telfer: Merchant Ship Service Performance Analysis

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at North British Station Hotel, Edinburgh), at 7. J. Wright and C. W. Marshall: The Construction of the Grid Transmission System in Great Britain.

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates) (at Watergate House, Adelphi), at 7 25.—D. Swallow Metal Omnibus and Car Bodywork.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—Eng.-Capt. J. C Brand: Pulverised Fuel To-day.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—Dr. Philippa Esdaile. Some Household Pests.

PHARMACEUTICAL SOCIETY, at 8.—Sir Herbert Jackson: The Nature of the Changes which take place in Various Forms of Glass (Lecture).
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—L'Abbe Breuil: Essai de co-ordination des faits geologiques relatifs aux industries paleologiques anciens au sud et sud-est d'Angleterre.

WEDNESDAY, MARCH 13.

INSTITUTE OF METALS (Annual General Meeting) (at Institution of Mechanical Engineers), at 10 A.M.—Prof. P. Saldau: Special Properties of Eutectics and Eutectoid Alloys in Binary Metallic Systems.—F. Hargreaves and R. J. Hills: Work-softening and a Theory of Intercrystalline Cohesion.—G. B. Brook and G. H. Stott: The Testing of Electro-deposits on Aluminium.—At 2.—Dr P. J. Durrant: The Constitution of the Cadmium-Rich Alloys of the System Cadmium-Gold.—D. Marie L. V. Gayler and G. D. Preston: The Age-hardening of some Aluminium Alloys.—C. Blazey: Brittleness in Arsenical Copper (II.).—Dr. P. J. Durrant: The Haughton-Hanson Thermostat: A Method of Fine Adjustment.—Dr. W. Hume-Rothery and E. Rounsefell: The System Magnesium-Zinc.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (Newcastle-upon-Tyne), at 7.15.—M. Waters. The Problem of High Voltage Measurement.
HALIFAX TEXTILE SOCIETY (at Halifax), at 7.30.—J. H. Edmundson: Treatment for Trade Effluent from Textile Trades.
ROYAL SOCIETY OF ARTS, at 8.—R. P. G. Denman: Loud Speakers.
SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (jointly with Royal Philosophical Society of Glasgow), at 8.—Dr. J. A. Cranston. Bicentenary Address on Joseph Black.
EUGENICS SOCIETY (at Linnean Society), at 8.—Dr. Margaret Rorke and Mr. Weatherall: Heredity in Education.
ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (at Northampton Polytechnic Institute), at 8.15.—J. W. Perring: Electroplating Plant.
INSTITUTE OF FUEL.—F. W. Goodenough: The Industrial Use of Gas.
HASLINGDEN DISTRICT TEXTILE SOCIETY (at Grammar School, Haslingden).—C. A. Harrington: The Weaving of Artificial Silks.

THURSDAY, MARCH 14.

INSTITUTE OF METALS (Annual General Meeting, continued) (at Institution of Mechanical Engineers), at 10 A.M.—H. C. Lancaster: The Importance of Design, and Setting of Large Kettles used for Refining and Low Melting Point Alloys.—Dr. W. Rosenhain and W. E. Prytherch: An Improved Form of Electric Resistance Furnace.—Dr. F. Campbell: Recent Developments in Electric Furnaces.—At 2.—C. Sykes: Alloys of Zirconium (II.).—Dr. J. Newton Friend and W. E. Thorneycroft: The Resistance of Zinc to Indentation (A Preliminary Account).—Dr. J. Newton Friend: The Solution of Plain and Amalgamated Zincs in Electric Batteries.—Dr. J. Newton Friend and W. E. Thorneycroft: The Silver Contents of Specimens of Ancient and Medieval Lead.
ROYAL SOCIETY, at 4.30.—Discussion on Ultramicroscopic Viruses infecting Animals and Plants (continued).
IMPERIAL COLLEGE CHEMICAL SOCIETY (in Main Chemistry Lecture Theatre, Royal College of Science), at 5.—Prof. C. K. Ingold: The Significance of Tautomerism.
LINNEAN SOCIETY OF LONDON, at 5.—Dr. E. J. Allen: The Origin of Adaptations (Hooker Lecture).
LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—N. S. Koshliakov: Note on the Remainders in the Asymptotic Expansions of Bessel Functions.—D. E. Littlewood: The Quadratic Equation in Quaternions.—C. E. Walsh: The Multiplication of Certain Series.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Prof. E. B. Verney: Polyuria (III.).
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Rev. W. H. Draper: The Handling and Interpretation of Metaphor.
INSTITUTE OF CHEMISTRY (Liverpool and North-Western Section) (at Liverpool University), at 6.—R. B. Pilcher: Alchemists in Art and Literature.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—T. N. Riley and T. R. Scott: Electrical Insulating Papers for the Manufacture of Power Cables.—S. G. Brown and P. A. Sporing: The Prevention of Ionisation in Impregnated Paper Dielectrics.
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—Wing Comdr. G. B. Hynes: Engine Performance Tests.
SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (Annual Meeting) (at Engineers' Club, Birmingham), at 7.—The Chairman and others: Miscellany.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Colour Group) (Annual General Meeting), at 7.
WEST CUMBERLAND SOCIETY OF CHEMISTS (at Workington), at 7.—Dr. Briggs: The Preparation of Coal for Sale.
OPTICAL SOCIETY (at Imperial College of Science) (Annual General Meetings), at 7.—At 8.—Ordinary Meeting.—W. D. Wright: A Re-determination of the Trichromatic Coefficients of the Spectral Colours.—Dr. J. S. Anderson: On the Testing of a Novel Photographic Shutter.
INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—W. Woodiwiss: Distribution.
ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Cinematograph Demonstration of a Film showing Work on Conditioned Reflexes in Prof. Pavlov's Laboratory, Leningrad.
BRITISH INSTITUTE OF RADIOLOGY, at 8.30.

FRIDAY, MARCH 15.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—Sir John Russell: Some Agricultural Problems in Australia.—F. L. McDougall: The Commonwealth Council of Science and Industry in its Relation to Agriculture.
ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 4.30.—Thunderstorms and the Maintenance of the Earth's Electric Field. Chairman, Prof. S. Chapman. Discussion to be opened by Prof. E. V. Appleton, and continued by R. A. Watson Watt, Dr. G. C. Simpson, Prof. C. T. R. Wilson, and T. W. Wormell.
BIOCHEMICAL SOCIETY (Annual General Meeting) (in Department of Physiology and Biochemistry, University College), at 4.30.—I. S. MacLean: Further Observations on the Sterols of Yeast.—H. J. Channon and A. C. Chibnall: The Isolation of n-nonacosane and di-n-tetradecyl Ketone from Cabbage Fat.—J. G. Davis and A. T. R. Mattick. The Metabolism of a Pigmenting Anaerobic Bacterium.—G. N. Richardson and R. K. Cannan. Reaction of Azine Compounds with Proteolytic Enzymes.—B. C. Guha and Prof. J. C. Drummond: Observations on the Concentration of Vitamin B_1.—Prof. J. C. Drummond, R. A. Morton, and K. H. Coward: A Critical Examination of the Methods for the Assay of Vitamin A.—C. R. Harington and S. S. Randall: Isolation of 3:5-diiodotyrosine from the Thyroid Gland.
MEDICAL OFFICERS OF SCHOOLS ASSOCIATION (Annual General Meeting) (at Society of Medical Officers of Health, 1 Upper Montague Street), at 5.—Sir Henry Gauvain: The Combined Education of Children Suffering from Physical Defects.
BRITISH INSTITUTE OF RADIOLOGY (Medical Meeting), at 5.—Urinary Discussion.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Recent Advances in our Knowledge of the Anatomy and Physiology of the Gall-Bladder.
BRITISH PSYCHOLOGICAL SOCIETY (Æsthetics Section) (at Bedford College), at 5.30.—Mrs. Roberts (Susan Miles) and others: Discussion on Inspiration.
SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (Annual Meeting) (at Liverpool University), at 6.—L. O. Newton: Boiler Feed Water.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Newcastle-upon-Tyne), at 6.—J. H. Gibson: Mechanical and Transmission Losses in Marine Engines, Shafting, and Propellers.
INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—C. F. J. Morgan: Wave-form Analysis.
SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Cardiff Technical College), at 7.—Annual General Meeting.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group) at 7.
SOCIETY OF DYERS AND COLOURISTS (Glasgow Section) (at 7 Gordon Street, Glasgow), at 7.15.—F. Asquith: The Necessity of Application of Fast Colours on Textile Fabrics.
JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—T. Grime: Locomotive Rating.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. V. M. Goldschmidt: The Distribution of the Chemical Elements.
SOCIETY OF DYERS AND COLOURISTS (Manchester Section).—Short Papers.

SATURDAY, MARCH 16.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Molecular Motions in Rarefied Gases (III.).
GEOLOGISTS' ASSOCIATION (North-East Lancashire Group) (at Blackburn Technical College), at 7.—J. Ranson: The Evolution of the Craven Highland.
PHYSIOLOGICAL SOCIETY (Annual General Meeting) (at University College).

PUBLIC LECTURES.

FRIDAY, MARCH 8.

KING'S COLLEGE, at 5.30.—C. J. Gadd: Assyrian Studies in the Present and Future.
SURVEYORS' INSTITUTION, at 5.30.—Prof. J. S. Huxley: Heredity and Society (delivered in connexion with the Institution of Professional Civil Servants).

SATURDAY, MARCH 9.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—R. W. Sloley. The Cave-Artists of the Stone Age.

MONDAY, MARCH 11.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE, at 5.30.—Prof. F. Fulleborn: Some Biological and Epidemiological Aspects of Helminthic Infection. (Succeeding Lectures on Mar. 12 and 13.)
EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—F. R. Petherbridge: The Spraying of Fruit Trees.
ROYAL SOCIETY OF ARTS, at 8.—G. Mowlem Burt: The Making of a Modern Building, with Cinema Illustrations (Bessom Gift Chadwick Lecture).

THURSDAY, MARCH 14.

FARADAY SOCIETY (at Chemical Society), at 2.30.—Prof. V. M. Goldschmidt: Crystal Structure and Chemical Constitution, and General Discussion on same subject by Dr. W. T. Astbury, Dr. J. D. Bernal, Sir W. H. Bragg, Prof. W. L. Bragg, Prof. P. P. Ewald, Prof. F. M. Jaeger, Dr. N. H. Kolkmeijer, Mrs. K. Lonsdale, Prof. T. M. Lowry, Dr. H. Mark, Dr. A. Muller, Dr. H. S. Piper, F. I. G. Rawlins, Prof. A. Reis, Prof. E. Schiebold, Dr. K. Weissenberg, and Prof. A. Westgren.

SATURDAY, MARCH 16.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—J. E. S. Dallas: Saxon Churches and their Remnants.

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NATURE

SATURDAY, MARCH 16, 1929.

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No. 3098, Vol. 123]

The Natural History Museum at South Kensington.

ZOOLOGISTS, by an overwhelming majority in open meeting, have expressed their sense of dissatisfaction at the present system of control of the British Museum of Natural History, which is mainly devoted to their science and is regarded by them as their place of reference for all questions relating to the different species of animals. This Museum is a branch of the British Museum, the home of which is at Bloomsbury, its chief function being the care of art and ethnological collections and the maintenance of a Library. It is governed by a Board of fifty-one Trustees, of whom the Archbishop of Canterbury, the Lord Chancellor, and the Speaker of the House of Commons are Principal Trustees.[1] There is also a trustee appointed by the Sovereign, and twenty-four 'official' trustees. Among these are the president of the Royal Society and the president of the Royal College of Physicians—the sole representatives of the natural sciences. There are in addition nine representatives of families whose magnificent gifts have enriched the State. Several distinguished men of science are included, however, among fifteen trustees 'elected' by their colleagues on the nomination of the principal trustees.

The trustees act through a standing committee of twenty members, which meets ten times a year at Bloomsbury and eight times at South Kensington. This committee consists largely of the elected trustees "appointed because they are known to be interested in the work as well as competent," and it guides the administrative business of each museum in an efficient manner. The direction, however, of a museum of natural history is very different from that of a picture gallery or an art museum: the problems which come before the governing body for solution require, therefore, a different kind of knowledge, and unless governed on different lines, neither institution can achieve full success or have full scope for development. Indeed, it is obvious that the policy of the Natural History Museum is controlled by its director, and his duty—to maintain its collections—necessitates the choice of a systematic specialist, a side increasingly separating year by year from university and industrial research. To assist the director effectively, he requires a representative body of naturalists and industrialists as trustees; and such

[1] A full account of the method of governing the Museum is given in the very interesting Memorandum presented by Sir Frederic Kenyon to the Royal Commission on National Museums and Galleries and printed in the volume of evidence, p. 51.

a body would not have the requisite knowledge or interest for the care of the priceless collections at Bloomsbury.

Under these conditions it is necessary to consider the advisability of severing the bonds which bind the two sides of the British Museum together. The director of the British Museum is the head accounting officer for both, and hence alone has access to the Treasury. While preserving their connexion and governance, a separate accounting branch for the Natural History Museum was offered, but its then director refused, not wishing to be troubled while he had a building free from congestion, and a science at that time scarcely connected, even remotely, with public health and industry. This change might be made now, but, while certainly beneficial, does not go to the root of the matter. Rightly or wrongly, naturalists have shown their dissatisfaction with the present arrangements by repeated memorials to the Government of the day during the last sixty years. In 1866, while the collections were still housed at Bloomsbury, they presented a memorial to the Chancellor of the Exchequer in which they state their view in clear terms: "We are of opinion that it is of fundamental importance to the progress of the Natural Sciences in this country that the administration of the National Natural History Collections should be separated from that of the Library and Art Collections, and placed under one officer who should be immediately responsible to one of the Queen's Ministers." To this memorial twenty-five signatures only were appended, but they were those of the foremost naturalists in the country, Charles Darwin, Huxley, Hooker, Lord Lilford, Wallace, and others—men of international renown.

The Royal Commission on Scientific Instruction and the Advancement of Science took evidence on this matter with great care. The commissioners summarise the evidence they received by expressing their opinion in 1874, "that the objections to the present System of Government of the British Museum by a Board of Trustees, as at present constituted, so far as relates to the Natural History Collections, are well founded; and we have been unable to discover that the system is attended by any compensating advantages." They recommended that the director "should be appointed by the Crown . . . and under the control of a Minister of State, to whom he should be immediately responsible." They also suggested an expert Board of Visitors, the members of which should be appointed for a limited period, but be re-eligible, and who should make annual reports to the Minister, to be laid before Parliament.

Nothing was done, and the Council of the British Association in 1879, a bill having been passed in the previous session to authorise the trustees to transfer the Natural History Collections into the new building at South Kensington, without any reference to a separation in governance, memorialised the First Lord of the Treasury to this end, but without effect. The superintendent of the Natural History Museum was made director in 1885 with a comparative independence, which was revoked in 1898. In 1908 a deputation, representative of zoology, botany, and geology, was received by the Prime Minister (Mr. Asquith) and asked for a full official inquiry into the organisation of the Natural History Museum. This was refused, as the trustees are a statutory body with whom the Government is powerless to interfere, an extraordinary position for a Prime Minister. He sympathised with the view that the director should have a free hand in the management of his department, and promised to convey to his fellow trustees of the British Museum all that the deputation had suggested. No alteration, however, was made.

In the meantime zoology has advanced by leaps and bounds. It is no longer a subject of purely philosophical interest. That the facts of heredity in man and animals are vital to the due governance of any State is now clear. Fisheries to a large extent depend on the study of the development of fish and of their habits at different ages in relation to the physical and chemical conditions of the water in which they live. The study of wools, silks, and hides has materially affected important industries, and all breeding is carried on for specific ends, for food, for transport, or for raw products of manufacture. The microscopical study of unicellular animals has resulted in the amelioration of the lot of mankind in respect to malaria and many other diseases, and scientific measures are in force over a large part of Africa against sleeping sickness. The Imperial Bureau of Entomology has its centre in the Natural History Museum, much of its work based on the national collections, and especially cares for crops so far as insect and other attacks are concerned. Many molluscs are valuable as food, some for their shells, and the study of corals and marine plants is necessary in respect to navigation in the tropics. Indeed, there is to-day the recognition that the study of animals is vital to man's civilisation and progress, and all our colonies employ specialists to apply the laws of their science.

These laws are largely the aims in research at the universities, the understanding of the structure in relation to the manifold activities of the living matter upon which all organisms depend. The two sides of this and of all sciences are inextricably bound, for progress in understanding must always precede scientific application.

Representatives of all these aspects of animal life look to the Natural History Museum to catalogue and to store specimens for reference, and there is not a single group which is free from their activities. All animals have fundamental points of relationship, and it is commonly essential for an investigator to have to refer to a dozen or more forms in as many groups. They are vitally interested in the Natural History Museum, and they cannot agree, to-day, with Mr. Asquith, in 1908, that the trustees are "equally cognisant of natural history and archæology" in the sense of knowledge of the needs of scientific and applied zoology. They do not see how due representation of their present and future aims can be given without such a large increase in the body of trustees as to amount to a complete reconstruction. They consider that the Museum in future will have to extend its activities into the field and to collect the animals it requires, if it is to maintain its utility. A director brought up within its walls for twenty or thirty years will even, in the next decade, be necessarily out of touch with his fellow zoologists outside, yet it would be deplored if his post, which should be the ambition of every member of the staff, should on a vacancy be filled necessarily from outside.

With these views scientific men generally find themselves in cordial agreement. They ask for no exceptional treatment, only for their affairs to be managed by a board of governors, which may be divided into those who have knowledge and judgment in respect to their activities, and those who are interested in the successful prosecution of such for national ends. We feel that there is no reason to perpetuate any form of governance by trustees or otherwise, if a better method can be devised. Evolution is equally a law in organic science and in national affairs; and for the welfare of both, progress is essential. No State is wise to refuse inquiry if any class of its subjects clearly demands it, and there seems to be practical unanimity here. Fortunately, a suitable body for such investigation is in existence—the Royal Commission on National Museums and Galleries; and the evidence submitted is so cogent and suggestive that we are confident it will lead to constructive conclusions.

British Floods and Droughts.

British Floods and Droughts. By Dr. C. E. P. Brooks and Dr. J. Glasspoole. With an Introductory Note by Dr. Hugh Robert Mill. Pp. 100 +2 plates. (London: Ernest Benn, Ltd., 1928.) 10*s.* 6*d.* net.

THIS book will attract many readers by its title, and they are not likely to be disappointed in its contents, which embrace entertaining accounts of notable floods and droughts in the British Isles back to quite early times, together with a wealth of statistical data about rainfall fluctuations compressed into a comparatively small volume. In the rain-rich climate of the British Islands, flooding is perhaps a more familiar condition than one of drought, but, as the authors truly observe, the vicissitudes neither of one nor the other are anything but mild compared with what occur in many other countries. In fact, it would be true to say that the climate of these islands is well-balanced or even-tempered, not in spite of its variability but because of it, inasmuch as excesses in any direction rarely last long enough to pass from the stage of an entertaining diversion from the monotony of normal conditions into that of serious distress and danger. In other words, the weather here provides plenty of stimulus, physical and mental, at a smaller cost in life and suffering than is the case in some parts of the world.

After an introduction on the general subject of rainfall in the British Isles, Dr. Brooks and Dr. Glasspoole, experts in this subject, arrange the fourteen chapters of their book into three parts: I. Great Rains and Floods; II. Droughts; III. Variations of Rainfall. British floods are of several types. The most familiar floods are the widespread, slowly rising river-valley floods that may follow excessive rainfall at any season of the year, but most frequently in winter when melting snow may also be a factor. The great Thames floods of November 1894, the Severn floods of May 1886, the Tees floods of September 1927, the Norwich floods of August 1912, the destructive thaw floods in the Scottish Highlands of January 1892, the historic Morayshire inundations of August 1829, are all outstanding examples of this class of flood. The Norwich flood forms the subject of the frontispiece. It was caused by a cyclonic downpour yielding 8 inches of rain in 24 hours on the top of previous heavy rains.

Floods of the 'cloud-burst' type in association with summer thunderstorms are more localised but also more dangerous, for they rise suddenly

when 5 or more inches of rain come down in a few hours of storm, and the water seems to fall in a solid sheet. The Louth disaster of Whitsuntide 1920, when 22 persons were drowned, as a great thunderstorm burst over the Lincolnshire Wolds, was of this character. A similarly impressive storm took place at Driffield at the foot of the Yorkshire Wolds on July 3, 1892. Cloudbursts, however, have been peculiarly prolific in the mountainous districts of South Wales and along the bold Pennine–Cheviot backbone of northern England. On July 2, 1893, one such storm bursting over the wilds of the Cheviots ploughed up many acres of black peat on the desolate fellside of Bloodybush Edge, Northumberland.

Of tidal floods, the most serious of modern times was that of Jan. 6, 1928, on the east coast and up the Thames estuary, taking toll of fourteen lives in London. It was due to the combined factors of a spring tide, a severe gale in the North Sea, and an upper Thames charged with snow-water. In the Middle Ages when, according to Prof. Otto Pettersson, both the tide-raising forces and the storminess were at a maximum, tidal floods caused enormous devastation and loss of life on the North Sea coast both of England and Holland. We have also floods due to the failure of dams, as when 245 lives were lost by the bursting of the Bradfield Reservoir, near Sheffield, on Mar. 11, 1866.

British droughts appear to have been severe in the eighteenth century, but in modern times the worst droughts of a protracted character were probably those of 1887 in the north-west of England and 1921 in the south-east, when there was a great dearth of water and milk in many districts. The great spring drought of 1893, however, was more acute while it lasted, many places in Kent and Sussex, as well as London, experiencing two or more absolutely rainless months. Dry weather, while it lasts, can be very intense in the wet western parts of the British Isles, but it has more definite bounding dates without the periods of faltering rainfall before and after, which are sometimes so pernicious in the dry eastern parts.

The book contains useful information about the extreme variations of rainfall since the establishment of reliable rainfall records on an extensive scale, that is, from about 1870. Thus the highest annual rainfall total on record is 247 inches at the Stye Head, Cumberland, in 1923, and the lowest, 10 inches, at Margate, in 1921; but the latter year was only the driest in the south-east of England, whilst the former was nowhere near the wettest over the British Isles generally. The highest two daily totals, close to $9\frac{1}{2}$ inches, both, curiously enough, belong to Somerset, the one case at Bruton on June 28, 1917, and the other near Bridgwater on Aug. 18, 1924. The longest duration of *absolutely* continuous rainfall, namely, $58\frac{1}{2}$ hours, is on record for Camden Square, London, between 1 P.M. on June 11 and 11.30 P.M. on June 13, 1903. As the duration of continuous rain is an interesting and important aspect of climate, it is to be regretted that the authors do not warn their readers that the number of self-recording rain-gauges is relatively small, and that it is unlikely that London really holds such a record. In the hill districts of Britain where the rainfall is excessive, bad weather is often of a most unrelenting character. Rain that will cease for an interval in the plains has there a way of simply altering its character, of changing its tune, so to speak, from heavy driving sheets to a teasing, drenching drizzle, and back again, and it is highly probable that in the high hills sixty or more hours of continuous rain is not very uncommon.

The methods adopted by the authors for estimating the rainfall of the country to a good approximation in earlier periods when rain-gauges were few are ingenious, whilst their treatment in the last chapter of the study of weather periodicities and recurrencies is cautious but suggestive. The periodic component in the make-up of the weather is, as Capt. Brunt has shown, small, and of very little use in forecasting; but the curves produced by Drs. Brooks and Glasspoole permit of a hope, though not a forecast, that the tide is about to turn, and that the wet spell of years that has marked the first quarter of the century, and especially the last six years, will soon be broken, with a tendency to finer summers. May we say, however, that we think the authors have been a little too insistent in their emphasis on the dismal side of rainy summers like 1924 and 1927? Excessive summer rains are admittedly inconvenient and may worry the farmer, but they bestow lavish beauty upon earth and sky and play no small part in the making of "England's green and pleasant land." The form and lighting of the clouds and the wild and fantastic sunsets in a rainy summer are incomparable! Moreover, there are always plenty of delightful intervals and ideal days in the worst of summers if people would only choose to see them, and in this connexion the authors rightly point out that the wet August Bank Holiday of 1927 gave the whole summer a reputation which it did not deserve.

L. C. W. Bonacina.

Scottish Ornithology.

The Geographical Distribution and Status of Birds in Scotland. By Evelyn V. Baxter and Leonore Jeffery Rintoul. Pp. vii + 425. (Edinburgh and London: Oliver and Boyd, 1928.) 15*s.* net.

THE feathered population of the British Isles has been subjected of late years to scrutiny so intense as to cause misgiving, and in some cases indignation, among such lovers of birds as are not specialists.

The conditions necessary for the satisfaction of the scrupulous framers of ornithological statistics imply the slaughter, euphemistically termed the 'collection' or 'securing,' of very many harmless birds. In the *Zoologist* for January 1913, Dr. C. J. Patten, in discussing the reported occurrence of four Redbreasts, *Erithacus rubecula*, at the Tuskar Lighthouse, remarked: "The birds were not captured, and so these occurrences cannot carry the same weight that they would had the specimens been secured and forwarded for corroboration."

In their volume on "The Geographical Distribution and Status of Birds in Scotland," Miss Baxter and Miss Rintoul are at pains to distinguish between the British and Continental forms of several species. In regard to the Redbreast, for example, while they record the British form as resident in every part of Scotland except Shetland and St. Kilda, the Continental variety is reported from only fourteen localities. Now, whereas the difference between the two subspecies cannot be detected until specimens are in hand, hundreds of Redbreasts must have been 'collected' to establish a fact not of first-rate importance. We do not accuse the authors of a direct share in such slaughter, but their statistics are founded on the result of industry in that line on the part of others; and they inform the reader in the preface that "a great deal of work remains to be done before we have a comprehensive knowledge of the status in Scotland of even our commonest birds."

We note with satisfaction that the authors observe timely reticence by withholding information about certain scarce birds, remarking that "in some instances in the interests of birds themselves it has been necessary to suppress the localities where they breed; for example, the Greenshank in Southern Scotland." It would have been well to observe the same precaution in respect to some other species—the Chough, for example, which formerly used to breed in many parts of Scotland but is now resident in two places only, where it is in imminent danger of extermination owing to the hostility of jackdaws and the baneful industry of collectors.

The authors consider it expedient to comply with modern practice in duplicating specific names, and I suppose we must not attribute it to a deficient sense of humour which sanctions the diminutive wren to be heralded as *Troglodytes troglodytes troglodytes*; but surely injustice is done to the great pioneer of classification by adding (L) to these cumbrous titles. Linnæus was content to denote the wren as *Motacilla troglodytes*, and assuredly he would have disclaimed having laden the Grey Plover with such cacophonous polysyllables as *Squatarola squatarola squatarola*! Clumsy nomenclature such as this causes the enemy to blaspheme and friends to complain. In such cases as it may be desired to duplicate the specific name, this might be conveniently indicated by adding a numeral (2).

The Buffet-headed Duck, *Clangula albeola*, is not mentioned in the volume under review, although Yarrell records a solitary instance of its occurrence in Orkney in 1841, and states that the bird was to be preserved in the Natural History Museum at Margate.

The foregoing frank criticism must not be interpreted as unfavourable to what is a thorough piece of work, which must have cost the authors no slight labour to compile and will prove very useful for reference. HERBERT MAXWELL.

Crystal Physics.

(1) *Lehrbuch der Kristallphysik (mit Ausschluss der Kristalloptik).* Von Prof. Dr. Woldemar Voigt. Nachdruck der ersten Auflage ergänzt durch eine spätere Arbeit des Verfassers und mit einem Geleitwort von Prof. M. v. Laue. (Sammlung von Lehrbüchern auf dem Gebiete der mathematischen Wissenschaften mit Einschluss ihrer Anwendungen, Band 34.) Pp. xxvi + 978. (Leipzig und Berlin: B. G. Teubner, 1928.) 41 gold marks.

(2) *The Physics of Crystals.* By Dr. Abram F. Joffé. Edited by Prof. Leonard B. Loeb. Pp. xi + 198. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1928.) 15*s.* net.

(3) *Bibliography of Crystal Structure.* By Jared Kirtland Morse. Pp. xix × 164. (Chicago: University of Chicago Press; London: Cambridge University Press, 1928.) 15*s.* net.

IT cannot be too strongly emphasised that crystal physics is no longer a highly specialised branch of physics, dealing with solid matter in what was

formerly thought to be a comparatively rare state. The new crystallography has shown, by the study of the interaction of X-rays and solids, that the normal stable state of most, and probably all, solid matter is essentially crystalline; that is, there is always a tendency for a group of ions, atoms, or molecules of the same kind to arrange themselves in the solid state in an orderly way. Even such substances as stretched rubber and gelatin, and the fibres of our bodies, have given evidence of an orderliness in the arrangement of the units from which they are built. This new outlook makes specially welcome the present volumes on crystal physics.

(1) Since Voigt's "Lehrbuch der Krystallphysik" has been reprinted by the photomechanical process, it is identical, save for a few additions, with the original edition of 1910. Its outlook is therefore essentially that of classical crystallography. The whole field is covered from geometrical and mechanical to electrical properties of crystals. There is, unfortunately, no index. Naturally, for particular subjects one would look to other sources, such as Love's "Elasticity" or the Geiger and Scheel "Handbuch der Physik," but there is no other book covering the work up to 1910 so well. The treatment is mathematical wherever possible, and there is for the research worker too little detail of experimental methods. Nevertheless, this reprint is of value, and since the original is so comprehensive and the outlook so classical, it would be much simpler to write an entirely new book than to revise Voigt's monumental work. In its present form it gives the research worker a good idea of the many types of research possible in crystal physics.

(2) In Joffé's book we have an attractive account of twenty-five years' research upon certain problems relating to the elastic and electrical properties. An invitation to give a course of lectures in the University of California was used as an opportunity to organise into a consistent whole the results of many researches carried out by Joffé and his collaborators. The outlook is fundamentally modern, as can be seen by the opening of the first lecture, where a crystal is defined as a regular arrangement of small units (atoms, ions, or molecules). The electrical theory of crystal lattices is developed, and it is pointed out that no more than the 10^{-15} part of the space is occupied by the electrons and nucleii, the crystal being regarded as an empty space with small charged particles distributed at enormous distances apart.

In the first six lectures it is shown how the general predictions of the electrical theory were checked both qualitatively and quantitatively by a diverse series of experimental studies upon the elastic properties of crystals. The fascinating account of these experiments admirably conveys the impression of research workers absorbed in their work and ready to adopt any tactics to solve their particular problems. For example, no sooner is the X-ray Laue method well established than it is applied to the study of the elastic limit (Lecture IV.) with results not easily attainable by other methods.

The remaining eleven lectures deal with certain electrical properties of crystals in a way that gives the reader the thrill of research well and truly carried out. For other research workers there is perhaps too little of that important section of research laboratory, the library. In the chapters on the mechanical properties of crystals, one looks in vain for such names as Carpenter, Elam, and Taylor. The book must not, therefore, be used as if it were a summary of work so far done in the subjects. Its title is misleading, since in the preface it is clearly stated that only a limited portion of the field of the elastic and electrical properties of solids is covered. Some of the work discussed would, however, otherwise be available only in Russian. The English is sometimes a little difficult; for example, a statement in the preface that "all atoms of a crystal are in the same relative position" is untrue, as it stands. The most notable feature of the book is that such interesting and valuable work is presented so as to make the reader feel that he is himself discovering the facts with the research workers in the laboratory.

(3) We turn now to the third volume, which is published as the first *Bulletin* of the Crystal Structure Laboratory of the University of Chicago. The greater part of this is a bibliography of publications on crystal structure and related topics published between 1912 and 1927. The classification is into sixteen groups according to the year of publication, and the papers of each year are arranged alphabetically under authors. The title of each paper is given in English. Joint papers are placed under the name of the author whose name appears first on the paper, but there are no cross references. A set of reprints of one well-known worker was used to test the completeness of the bibliography. Four out of eight papers had been omitted, one from the *Phil. Mag.*, one from the *J. Chem. Soc.*, and two from the *Min. Mag.*, all well-known journals. In spite of this the bibliography seems to be very comprehensive, and its use will be very considerably increased when an index is provided in one of the later *Bulletins*.

In order to make known (" better known " in the original) the work of the Crystal Structure Laboratory, the bibliography is preceded by an introduction which is largely made up of terminological inexactitudes and is often in questionable taste. In one place a programme of investigation of the laboratory is given, consisting of a list of apparently every known type of work in X-ray crystallography classified into four sections. We are then actually told that " already fundamental contributions have been published in the majority of these sections." We need be in no doubt as to what these fundamental contributions are. " The most striking and important contributions of the Crystal Structure Laboratory to date have been in the solution of the structure of these two substances —methane and benzene." The papers giving the solutions are reprinted in the *Bulletin*, and appear to be nothing more or less than interesting speculations. They certainly do not justify the statement that " the structure of the benzene ring has been solved." The crystal structure proposed for ethane is not even hexagonal, and the paper suggests that the author is unaware of this disagreement with crystallographic evidence. Moreover, the normal procedure of the X-ray crystallographer is to reject a proposed structure if observed and calculated intensities of X-ray reflections disagree. Mr. Morse prefers to suggest that such disagreements between his own proposed structures and the experimental observations of others " may lead to a fundamental revision of our present simple notions concerning the scattering of atoms."

Apparently the only structure work that has been completed in the Laboratory is a determination of the space group of certain sulphates. For this purpose the Laue method alone was used. Whilst it is true that really able workers, such as Wyckoff, have used this method exclusively with great success, the tendency nowadays is not to rely solely upon one method. There appears to be little point in equipping this Laboratory so fully if the full advantages available are neglected.

The thought of possible injury to the feelings of Mr. Morse and the University of Chicago caused the reviewer to hesitate long before referring thus to the first publication of a newly established Laboratory, but some expression should surely be given of the sense of injury produced in the, comparatively speaking, poverty-stricken research workers in pure science in Great Britain when they see part of the world's research funds used in this way while so many problems lack the support needed for their investigation. W. H. GEORGE.

Our Bookshelf.

Sheep Production. By Levi Jackson Horlacher. (McGraw-Hill Publications in the Agricultural and Botanical Sciences.) Pp. x+418. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1927.) 20*s.* net.

THIS book is partly the result of the impetus which has been given to the sheep industry in the U.S.A. during the last five years, and its consequent repercussion on the enrolments in courses on sheep husbandry in the American agricultural colleges. It is written primarily for the sheep producer of America. In consequence, its value to the British agriculturist is not excessive. To the student of animal ecology, who may desire a rapid survey of the growth and distribution of the sheep industry in the United States, it will be useful. The treatment, while not exactly exhaustive, cannot be described as superficial. A large amount of information, hitherto only available in *Bulletins* and *Circulars* of the U.S. Department of Agriculture and in various publications from State experimental stations, has been gathered together under one cover, and made readily available by a satisfactory index.

The book is divided into four parts. An introductory portion describes the history and development of sheep production, anatomy (briefly), judging, and feeding and digestion. General accounts of each are given, which, while adequate for the needs of the agricultural student, are of little use to the advanced worker. Part 2 consists of an account of the general principles of sheep breeding, with a description of each of the breeds of American importance. Part 3 deals with the establishment and management of a flock, having regard to the suitability of certain breeds and crosses for different localities and markets available. Methods of production for mutton and wool are well and clearly stated, and this part will probably be of greatest interest to British readers. The concluding part consists of a short glossary of terms connected with sheep and wool.

The book is, on the whole, well written, opinions are clearly stated, and logical reasons are offered for most of the conclusions drawn. The illustrations, of which there are 137, are either diagrammatic or reproductions from photographs, and are mostly very good, although the American tendency to include landscape views, which either have but little bearing on the subject or mask its outlines, is evident in a number of them. The publishers have done their part of the work in their usual satisfactory manner.

La chimie d'hier et d'aujourd'hui. Par Dr. A. Kirrmann. Pp. vii + 148. (Paris: Gauthier-Villars et Cie, 1928.) 15 francs.

THIS is an interesting little book, which may be read with profit by the layman and with pleasure by the enterprising student of chemistry; so far as we are aware, it has no exact counterpart in English. It is very successful in affording within a modest

compass a very readable general account of the nature and scope of modern chemistry, of the problems which the chemist has to face, and of his methods of attacking them in the laboratory. In tracing the historical development of chemistry, the author rightly insists that "rien ne pouvait ensuite mieux préciser le caractère de cette science que l'étude de son développement historique, de l'évolution des idées directrices et de la description de l'enrichissement progressif des connaissances humaines."

The work contains a short list of technical terms and thumb-nail biographies of some fifty celebrated chemists of the eighteenth century and later. The *cognoscenti* will appreciate the statements that among the qualifications of the successful research worker are "une imagination active," "une grande habileté manuelle," "une patience sans bornes," and "une érudition suffisante pour éviter de s'attaquer à des questions déjà résolues." We commend also to the attention of all optimistic candidates for the Ph.D. after nine terms' research the closing sentence of this chapter : "Le travail de laboratoire peut être terriblement ingrat et le moindre résultat exige une dépense sans compter et de temps et d'efforts." J. R.

Die Physik, 1914–1926 : Siebzehn ausgewählte Kapitel. Von Prof. O. D. Chwolson. Aus dem Russichen übersetzt von Georg Kluge. Pp. ix + 696. (Braunschweig : Friedr. Vieweg und Sohn, A.-G., 1927.) 35 gold marks.

This volume is similar in many respects to Prof. Andrade's "Structure of the Atom," both in its scope and in the obvious enthusiasm with which it has been written. It partakes, however, rather more of the nature of a collection of independent essays, whilst it has a natural bias towards the German and Russian points of view. Written as an appendix to Prof. Chwolson's general text-book of physics, it had its origin in an attempt to summarise for Russian students the work done elsewhere between 1914 and 1922, when the country was isolated ; how well it has succeeded may be judged from the fact that it has been translated into French as well as into German.

A commendable balance between theory and experiment has been maintained throughout, and there is a satisfactory selection of good figures and of tables of numerical data, whilst each section includes a bibliography. Physics has advanced considerably since 1926, but even where much new ground has been broken, Prof. Chwolson's accounts of the older researches are stimulating, and should be particularly valuable for physics students starting for the first time on experimental research.

Cambridge Observations. Vol. 24, Part 2 : *Catalogue of Zodiacal Stars for the Equinox 1900·0 from Observations made in the Years 1900–1918.* Pp. vi + 58. (Cambridge : At the University Press, 1928.) 5*s*. net.

Sir David Gill indicated the importance of accurately surveying all the brighter stars in the zodiacal region, to render them available as comparison stars for the moon and planets. Of late years the value of such observations has been further emphasised, since Prof. Brown, Dr. Spencer Jones, and Dr. Innes have all shown that very accurate determinations of the moon's errors can be obtained from observations of the occultations of stars, provided that good positions of the latter are available. The Cambridge University Observatory has been engaged since 1900, but with many interruptions, in observing the stars in Sir David Gill's list, and a catalogue containing positions for 1900·0 of 2588 stars out of the 2798 in Gill's list has been published. The average number of observations of each star is about five ; very few have less than three observations in each co-ordinate. The observations are not fundamental, but depend on Newcomb's positions of the standard stars. Magnitude equation has been applied ; it is nearly the same for all the observers, being in the mean 0·01 sec. for magnitude 4·5, and increasing fairly uniformly to − 0·08 sec. for magnitude 9·0.

The Right Ascensions were observed by eye and ear up till 1914, and by chronograph in 1917–1918. Proper motions have not been applied.

A. C. D. C.

A Text-Book of Inorganic Chemistry. Edited by Dr. J. Newton Friend. (Griffin's Scientific Text-Books.) Vol. 6, Part 1 : *Nitrogen.* By Dr. Edmund B. R. Prideaux and Herbert Lambourne. Pp. xxviii + 242. (London : Charles Griffin and Co., Ltd., 1928.) 18*s*. net.

A volume on nitrogen provides an exceptional opportunity for a chemist who is alert to the interesting features of his science, since such a volume necessarily includes the foremost technical problem of the day, that of the 'fixation' of nitrogen, as well as some of the most hotly debated questions of molecular structure. The latter category covers the problems of variable valency, mixed double bonds and co-ordination, and even then leaves the stereochemistry of the element to be dealt with in the light of modern knowledge. No higher compliment need be paid to the authors than that they have made adequate use of their opportunities, and have produced a volume which does justice to the fascinating element with which it deals.

The Ordinall of Alchimy. By Thomas Norton of Bristoll. Being a Facsimile Reproduction from Theatrum Chemicum Britannicum, with Annotations by Elias Ashmole. With Introduction by Dr. E. J. Holmyard. Pp. viii + 125. (London : Edward Arnold and Co., 1928.) 10*s*. 6*d*. net.

Dr. Holmyard has earned the gratitude of all interested in the history of chemistry by his preparation of this book. Norton's poem, although it has no particular value from the point of view of the development of chemistry, gives, if it is authentic, an interesting picture of early alchemy in Great Britain, and since the original is difficult to obtain, this reprint (in facsimile) will appeal to many readers.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Eddington's Hypothesis and the Electronic Charge.

PROF. SIEGBAHN has directed my attention to the paper in the *Proceedings of the Royal Society* for January 1929, p. 358, in which Prof. Eddington arrives at the relation between the electronic charge e and the ratio $hc/2\pi$,

$$\frac{hc}{2\pi e^2} = 136.$$

On page 174 of NATURE for Feb. 2, 1929, some editorial remarks are made concerning this relation, and it is stated that "*all* existing experimental evidence . . . are in favour of a value very near to 137." Inasmuch as I have carried out an investigation in this field, the results of which were mentioned in Eddington's paper, but which were published only in *Upsala Universitets Årsskrift*, 1928 (Diss., May 1928), I may be permitted to make a few remarks upon the subject.

The commonly accepted value of e ($4{\cdot}774 \times 10^{-10}$ E.S.U. $\pm$ 0·1 %) was determined by Millikan in 1916. There are, so far as I know, no redeterminations of e which claim the same degree of accuracy. In the investigation carried out by myself the absolute wavelength of the aluminum $K\alpha$-line was determined by means of a ruled, plane reflection grating. From this and the known crystal value of the same spectral line, I computed a new value of e, namely, $4{\cdot}793 \times 10^{-10}$ E.S.U. $\pm$ 0·3 %. In a recent paper (*Phys. Rev.*, Dec. 1928), A. P. R. Wadlund, using the same general method (Compton, 1925), gives a value of e ($4{\cdot}774 \times 10^{-10}$ E.S.U. $\pm$ 0·15 %) which is exactly the same as that found by Millikan.

In order to determine the reliability of these three values, each being the mean of comparatively few determinations, it is of importance to analyse in each case the distribution of the individually determined values around their mean. For each of his twenty-five investigated drops Millikan obtained a value of $e^{2/3}$, and from the distribution of these single values he has computed the 'probable error' to be $\pm$ 0·025 %. From the published $e^{2/3}$-values I have calculated each single e-value. From their distribution the 'probable error' was found by the usual methods to be $\pm$ 0·04 %, which agrees with that found by Millikan related to $e^{2/3}$, namely, $3/2 \times 0{\cdot}025 = 0{\cdot}038$. In the diagram (Fig. 1) I have plotted the number (Z) of values falling in the intervals 0-0·1 %, 0·1-0·2 %, etc., from the mean. The upper curve represents the error distribution for Millikan's determinations. The lower figure is the error distribution curve obtained in the same manner from my own single values (29). My mean value is 4·793 and is 0·4 % greater than Millikan's. At the bottom of the diagram I have plotted Wadlund's mean value with its published error limits and also its probable error as given in his paper. In his paper only one single value of the nine obtained is published, and if this is indicative of his series of measurements, his error distribution must be considerably wider than either Millikan's or my own. The position of the e-value belonging to this single value departs by 1 % from the mean, and the corresponding probable error is given as $\pm$ 0·18 % (see Fig. 1).

It should be pointed out that the error limits apportioned to each of these three e-values are not computed in the same manner. In Fig. 1, I have indicated by means of horizontal arrows the probable error Δ_p calculated in the usual manner from the formula

$$\Delta_p = \tfrac{2}{3}\sqrt{\frac{\Sigma\Delta^2}{n(n-1)}},$$

where Δ is the deviation from the mean and n the number of values obtained. The arithmetical mean error, Δ_m, is given by

$$\Delta_m = \frac{\Sigma\,|\,\Delta\,|}{n}.$$

Millikan's published error limits, Δ_a, agree with the value calculated from the relation

$$\Delta_a = \sqrt{\Delta_p{}^2 + \Sigma\Delta_s{}^2},$$

where the Δ_s are the systematic errors estimated

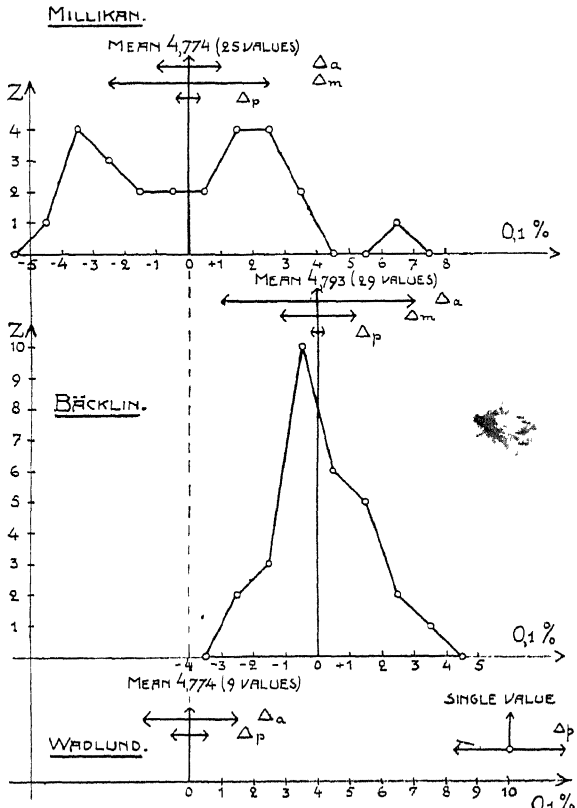

FIG. 1.

from the method used. In my case I have, for the purpose of this calculation, taken

$$\Delta_a = \sqrt{\Delta_m{}^2 + \Sigma\Delta_s{}^2},$$

Δ_m being much greater than Δ_p (see Fig. 1). It would require too much space here to explain in detail the error calculations of Wadlund. For this I must refer to his paper. The diagram is perhaps sufficient.

In my opinion it is of more physical significance to carry out such error calculations with the arithmetical mean error Δ_m, than with the so-called probable error Δ_p, which is commonly used without the necessary analysis of the error distribution obtained.

From the accompanying diagram it is, I believe, clear that from the experimental evidence we can scarcely decide whether 136 or 137 is the better value for Eddington's ratio, especially since h is not known with the same degree of accuracy as e. Moreover, it

should be remembered that the value of h is obtained with the aid of a value of e.

As to the Rydberg constant R, agreement between the spectroscopic value and that calculated from other physical constants is a criterion not only of the value of e but also of the other physical constants involved $(h, e/m)$.

ERIK BÄCKLIN.

Physical Laboratory of the University,
Upsala, Sweden, Feb. 15.

The Raman and Infra-Red Spectra of Carbon Dioxide.

MR. RASETTI's examination of the Raman spectrum of carbon dioxide as reported in his letter in NATURE of Feb. 9 is of extreme interest. He points out (1) a coincidence between (*a*) the infra-red frequencies deduced from the Raman spectrum, namely, 1284 and 1392 cm.$^{-1}$, and (*b*) the wave number difference between the band centres of the double doublet at $2 \cdot 7\ \mu$ and the doublet maxima at $4 \cdot 25\ \mu$ as given by Schaefer and Philipps (*Zeit. f. Physik*, **36**, 641; 1926), which are 1279 and 1381 cm.$^{-1}$; and (2) that there is no known band in the infra-red spectrum of carbon dioxide which would correspond with either of these.

A further examination of the absorption spectrum mentioned shows that the concordance is far from being a coincidence. There is perhaps no physical justification for calculating, as Mr. Rasetti does, the difference between the maxima in a simple Bjerrum doublet and the band centres in a double doublet. Adopting Schaefer and Philipps's nomenclature, we have four double doublets, A, C, F, and K (D and E being uncertain). The assumption of a triangular molecular model with two large and approximately equal moments of inertia, A, and one much smaller, C, gives as a general expression for the double doublet separation,

$$\Delta\nu = \left(\frac{1}{C} - \frac{1}{A}\right) h/2\pi^2$$

(assuming the absence of a zero branch). Now, the average value for this separation in the four bands quoted is 108 cm.$^{-1}$, which is 1392-1284, and we should be justified in assuming that the frequencies in question represent such a double doublet.

However, the connexion between the deduced values and the observed spectrum is closer still. (i) If we determine the wave number differences between the band centres in the double doublets and those in the 'undoubled' bands, we have the values recorded in Table I.

TABLE I.

Bands . . .	$C \rightarrow I$.	$K \rightarrow B$.	$B \rightarrow A$.
$\Delta\nu$ in cm.$^{-1}$	1262 1375	1293 1393	1264 1368

These values are of the same order as the deduced frequencies. (ii) If we perform the same operation on the double doublets themselves the agreement is exact, within the experimental error, $F \rightarrow A$ giving 1388 and 1282 cm.$^{-1}$. (iii) The frequency difference between the undoubled bands is a simple fraction of one of these frequencies; thus $B \rightarrow H$ is 687 cm.$^{-1}$ (approximately $\frac{1}{2} \times 1392$), and $E \rightarrow D$ is 637 cm.$^{-1}$ (approximately $\frac{1}{2} \times 1284$). There must consequently be some simple relationship between the double doublet separations and the band centre separations; and we actually find in the two frequencies deduced from the Raman spectrum, that if the former is taken as 107 cm.$^{-1}$, we have $1391 = 13 \times 107$, and $1284 = 12 \times 107$.

This fact is rendered more prominent by a reconsideration of the emission spectrum as determined by the writer in conjunction with Mr. K. H. Lih (Bailey and Lih, NATURE, **121**, 941; 1928). To account for the regularities in this spectrum, we assumed that the bands could be represented as multiples of a fundamental frequency given by $\nu_0 = 16 \times 10^{11}$, or in wave numbers, $53 \cdot 5$ cm.$^{-1}$, *i.e.* $\frac{1}{2} \times 107$, the half-value being adopted to provide for the just perceptible resolution of the band at $2 \cdot 84\ \mu$. Now, if we accept the possible presence of a band at 1284 cm.$^{-1}$ (Eucken, *Zeit. f. Physik*, **37**, 714 (1926), it is interesting to note, postulated the existence of an optically inactive frequency at $7 \cdot 86\ \mu$, *i.e.* 1272 cm.$^{-1}$), the emission spectrum can be represented in a very simple manner, as will be seen by a consideration of Table II.

TABLE II.

No. . .	1	2	3	4	5	6	7	8
λ in μ . .	1·46	1·70	1·99	2 40	2 84	3 12	4·46	(7 80)
ν in cm.$^{-1}$ obs.	6850	5890	5027	4167	3524	3206	2243	—
ν in cm.$^{-1}$ calc.	6848	5885	5029	4173	3531	3210	2247	(1284)
n . . .	64	55	47	39	33	30	21	12

The calculated wave numbers are obtained by multiplying $\nu_0 = 107$ cm.$^{-1}$ by n; in particular the bands 8, 7, 6, and 4 now become members of a series represented by $3\nu_0(1 + 3m)$. The above results were obtained with a rocksalt prism spectrometer; it is proposed to re-examine this spectrum with greater resolution and at higher sensitivity, when possibly other members of the series may be identified. It is difficult at the present to see the underlying physical significance of the above results.

C. R. BAILEY.

The Sir William Ramsay Laboratories of
Inorganic and Physical Chemistry,
University College, London, W.C.1.

The Fulcher Bands of Hydrogen.

IN a communication just published (in the *Proceedings of the Royal Society of Edinburgh*) I have shown that the Fulcher bands of hydrogen can be arranged in three branches (P', Q, and R'), the Q branches being identical with those of Richardson. The P' and R' branches have an initial level differing from that of the Q branch, while all three have a common final level, a fact proved conclusively by the intercombinations found to hold between them. This shows the final state to be an S state, as Birge has predicted.

It is of interest to inquire how these hydrogen bands fit in with the new mechanics, and in particular to determine the constant σ in the term form

$$B\{j(j+1) - \sigma^2\}.$$

An analysis of the bands shows that the terms fit this form provided j is given integral values. This is as it should be according to Mulliken's theory, if the emitting molecule is that of neutral H_2 (odd multiplicity). The lowest lines are R' (0), Q (1), and P' (2), which shows that σ'' is zero in the final terms, as we should expect for an S state.

While the major part of the term is clearly of the form just given, a preliminary examination of the term-differences showed that an appreciable 'correction term' in the fourth power of j (or j_k) is present. Such a term is to be expected on the old theory. Unfortunately, no general expansion for the band terms on the new theory is available. At the sug-

gestion of Prof. H. S. Allen, the following tentative term-formula was adopted :

$$F(j) = \Sigma X_n\{j(j+1) - \sigma^2\}^n,\ n = 1,\ 2,\ .\ .\ .$$

Here in the usual notation, $X_1 = B$, $X_2 = D$, . . . In using this formula we need only take into account as many terms as are likely to be required. Actually, we may obtain a good fit for the hydrogen bands by taking into account only the first two terms ($n = 1$ and 2). Such a two-term formula has in fact been found to give a good fit for bands consisting of a large number of members in the case of the blue-green bands of Na_2 ($^1P \longrightarrow {}^1S$) described by Loomis and Wood.

A least-square determination of the constants of the Fulcher null band $_0a_0$, taking into account the first four terms of the above formula, yields the following values for the final constants :

$$B'' = X_1'' = 33{\cdot}38879 \text{ cm.}^{-1},$$
$$D'' = X_2'' = -0{\cdot}0229274 \text{ cm.}^{-1},$$
$$X_3'' = 4{\cdot}8565 \times 10^{-5} \text{ cm.}^{-1},$$
$$X_4'' = -3{\cdot}1250 \times 10^{-7} \text{ cm.}^{-1}.$$

The initial constants agree in sign and magnitude with the above. Moreover, the two values of B' obtained for the initial state, one for the Q branch and the other for the P' and R' branches, differ sufficiently to allow the initial constant σ' to be determined within narrow limits. Its value comes out as $\frac{1}{4}$, the actual determination being 0·2506. This result is curious, and points to some, as yet unexplained, peculiarity of the term-form.

With this value of σ' we obtain

$B_A' = 29{\cdot}60537$ cm.$^{-1}$ for the Q series
and $B_B' = 29{\cdot}84408$ cm.$^{-1}$ for the P' and R' series.

It may be pointed out that in the case of the $^1P \longrightarrow {}^1S$ bands of Na_2 these constants only differ by 0·00001 cm.$^{-1}$. Thus, hydrogen seems to present possibilities for band analysis which are lacking for the heavier molecules.

It is hoped to discuss the Fulcher bands in greater detail in a future communication.

IAN SANDEMAN.

Physical Laboratory,
George Heriot's School, Edinburgh.
Feb. 1.

The Angular Distribution of Compton Recoil Electrons.

UP to the present the 'intensity-problem' of the Compton theory has remained unsolved. Many hypotheses have been put forward, and there exist two different solutions based on the new quantum mechanics ; experiment, however, has not given any definite decision in favour of either solution.

There are two ways of experimental test : the investigation of the angular distribution of the secondary quanta (scattered radiation), or the study of secondary recoil electrons. In both cases the decisive information may be obtained only by using very hard rays, that is, γ-rays. Wilson's cloud expansion method presents essential advantages in this respect. The spectral distribution of the secondary β-rays emitted under the recoil angles $\delta < 20°$ is known from my measurements published in 1927 (*Zeit. f. Phys.*, B. **43**, 354). More detailed data were reported at the conference on β- and γ-ray problems (Cambridge, July 1928). These data enable one to determine the corresponding statistical weights of the different spectral components of the inhomogeneous radiation used for each given distribution examined. The results of this comparison are thus independent of the supposed distribution of intensities in the primary spectrum ; this supposition in most cases being based on very untrustworthy data taken from an outside series of observations.

In the following table the angular distribution of a thousand β-ray tracks measured in the course of the last one and a half years (observed in the gas under the action of a narrow beam of γ-rays filtered through 3·5 mm. of lead) is compared with the results of calculation according to three different theoretical formulæ. In each individual case the recoil angle has been determined with sufficient accuracy by measuring Wilson's photographs on Pulfrich's stereocomparator. The figures enclosed in brackets in the column of observed values correspond to three separate series of measurements, including 408, 298, and 305 tracks each. The figures belonging to the first series are reduced in the proportion of 300 : 408. The comparison with the data supplied by the latest theories of Dirac–Gordon and Klein–Nishina is also shown in a diagram (Fig. 1). The areas limited by separate parts of the broken lines are proportional to the calculated number of electrons in the corresponding intervals, the circles giving the observed values of the mean ordinates for the same intervals.

Numbers of recoil electrons in different angular intervals.

	Observed		Calculated according to					
			Klein-Nishina		Compton		Dirac-Gordon	
		n_0	n_1	$\frac{\lvert n_1-n_0\rvert}{n_1}$	n_2	$\frac{\lvert n_2-n_0\rvert}{n_2}$	n_3	$\frac{\lvert n_3-n_0\rvert}{n_3}$
0°–10°	39, 34, 44	117	92	0,27	72	0,62	48	1,44
10°–20°	48, 54, 47	149	152	0,02	148	0,01	93	0,60
20°–40°	76, 81, 85	242	266	0,09	264	0,08	280	0,14
40°–60°	75, 66, 74	215	224	0,04	230	0,07	287	0,25
60°–80°	56, 55, 50	161	146	0,10	162	0,01	171	0,06
80°–90°	6, 8, 5	19	20	0,05	26	0,27	22	0,14
			$\overline{\frac{\lvert n_1-n_0\rvert}{n_1}}=0{,}095$		$\overline{\frac{\lvert n_2-n_0\rvert}{n_2}}=0{,}177$		$\overline{\frac{\lvert n_3-n_0\rvert}{n_3}}=0{,}44$	

Klein and Nishina's letter (NATURE, **122**, 398 ; 1928) contained a comparison of the intensity curves of scattered radiation calculated on the three theories mentioned above. In this case the curves differ considerably only in the region of large scattering angles, where the intensities of the scattered rays are extremely weak ; therefore any definite decision in favour of either curve is scarcely to be expected. The observed angular distribution of the secondary electrons, however, diverges from Dirac–Gordon's curve to a large degree and is definitely in contradiction to their theory.

Of all the three theoretical results compared above, Klein–Nishina's formula is in the best agreement with our data. The discrepancies, however, exceed even in this case the probable statistical deviations. These discrepancies also cannot be attributed to experimental errors only. We are evidently confronted with systematic deviations, which will be shown more clearly in a detailed paper shortly to be published.

The question of the angular distribution of secondary radiation is intimately connected with the problem of the determination of the scattering absorption coefficient as a function of wave-length. This relation is implicitly contained in the formulæ of Dirac–Gordon and Klein–Nishina, which determine the above distribution. The result of the comparison quoted above can be therefore considered as a serious argument against the scattering absorption formulæ deduced by Dirac and Gordon, as well as against the estimations of the wave-length of ultra-γ-rays based on this deduction.

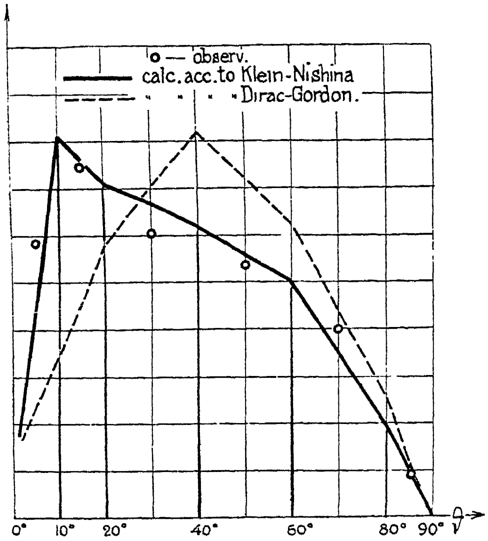

FIG. 1.—Distribution of recoil electrons.

D. SKOBELTZYN.

The Physical-Technical and
Polytechnical Institutes,
Leningrad, Jan. 22.

The Complexity of the K-β' Line of X-ray Spectra.

RECENT measurements of the X-ray spectrum line K-β', and the separation of this line from the K-β_1 line, make it remarkable that their separation had not been attained in the course of earlier measurements (M. Siegbahn, V. Dolejšek, *Zeit. f. Phys.*, **10**, 159; 1922), especially in the case of elements of low atomic number, where the difference between K-β' and K-β_1 is about 6 X.U.

N. Seljakov and A. Krasnikov (*Zeit. f. Phys.*, **33**, 601; 1925. NATURE, **117**, 554; 1926) distinguished the line K-β' for the element of atomic number 25 (manganese), and G. Ortner (*Akad. d. Wiss. Wien*; 1926. NATURE, **117**, 823; 1926) separated it in the case of some compounds of iron and cobalt. These investigations show that only with certain compounds are these lines distinguished, and this has suggested to us that, in the case of lower elements, the diffusion of this line is dependent upon the state of chemical combination.

We have now examined different manganese compounds with the object of determining this dependence, if possible, but within the limits of precision no relationship between the state of chemical combination and the breadth (diffusion) or displacement of the line has been found, and in all cases the K-β' line is readily distinguished (Fig. 1).

The microphotometric curves of the lines from different compounds make it apparent that the ratio of the lines K-β_1 : K-β' becomes greater for oxides than for free elements, in which case it coincides with the results of Seljakov and Krasnikov. The value of this ratio, in the investigations of Seljakov and Krasnikov, is found to be 2 : 1. The determination of the value of the intensity ratio from our measurements is not considered here; this is being investigated independently with J. Hrdlička, and the results will be presented in due course.

Although we could not ascertain, within the limits of our measurements, any influence of the chemical combination on the displacement of the lines, we

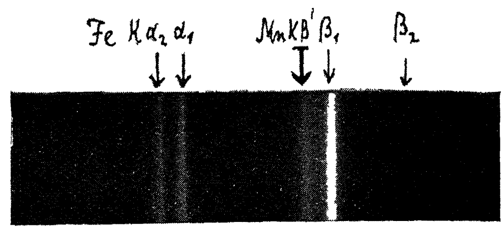

FIG. 1.

cannot say that it does not exist. Such quite small influence could manifest itself with the compounds—which are not stable on the anticathode—by the diffusion (broadening) of the lines. To eliminate such possible source of error, we used only the free metals for our measurements of the K-β' line of other elements.

The measured differences of this line from the K-β_1 line are shown in Fig. 2.

The curves (a, a) in this Fig. show also the different breadth of this line K-β' in the case of different elements. For the lower elements the breadth is greater —twice greater—than that of the K-β_1 line. With these elements we have found that the K-β' line is two

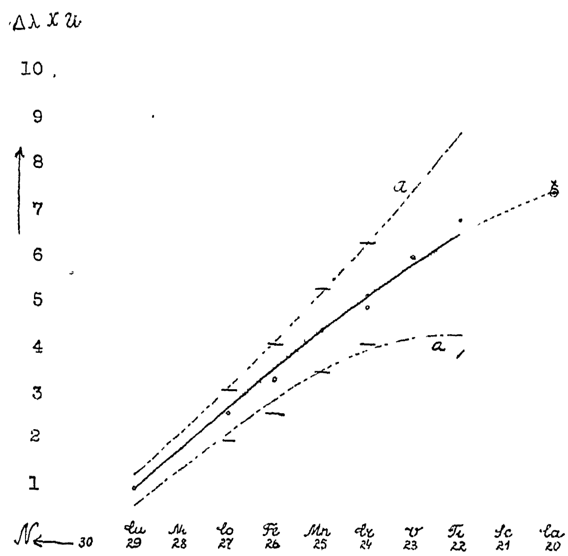

FIG. 2.

unresolved doublet-lines, which in the case of the higher elements are superimposed. As is well known, the difference $\Delta\lambda$ between the K-β' and K-β_1 increases with the decreasing atomic number. As one can see from Fig. 2, the breadth of the line increases simultaneously with the decreasing atomic number. That is the reason why it is so difficult to distinguish K-β' with elements of lower atomic number ($\Delta\lambda = c.$ 6 X.U.) as compared with those of higher elements ($\Delta\lambda = c.$ 2 X.U.).

We have measured, separating this line in all the

elements mentioned, the difference $\Delta\lambda$ from the middle of the lines contrary to our previous measurements of the edges of the emission bands. Therefore we can determine quite surely the energy frequency difference $\Delta\nu/R$ of the K-β_1 and K-β'. This difference of frequency resulting from our measurements $\Delta\lambda$ does not coincide with the values calculated from the frequency difference of the M_{II} and M_{III}-levels, and consequently these two lines cannot both be due to transition $K \longrightarrow M_{II}$, $K \longrightarrow M_{III}$, in agreement with the opinion of G. Ortner (*l.c.*) and D. Coster and M. F. Druyvesteyn, (*Zeit. f. Phys.*, **40**, 735; 1927).

Further, from our measurements we can see, by following the course of the $\Delta\lambda$ of these lines, their dependence on the atomic number (Fig. 2), that there is no peculiar change in the region of the iron family.

In conclusion, we consider that the K-β' is a complex line, and it is impossible to arrange the line in the scheme of Bohr and Coster. The origin of this line is as yet unknown.

V. DOLEJŠEK.
H. FILČÁKOVÁ.

Physico-Chemical Institute,
Charles' University,
Prague, Jan. 9.

Diœcism in *Ranunculus acris*.

DURING the course of a cytological investigation of the reproductive organs of diœcious and intergrade forms of *Ranunculus acris* L., in connexion with the genetical work of Mr. E. M. Marsden-Jones and Dr. W. B. Turrill, a matter of some general interest has arisen, which it is thought advisable to put on record forthwith.

Examination of a hermaphrodite flower showed that there are two distinct and successive phases in the development of the flower: first, a male or anther phase, marked by the commencement of physiological activity in the tapetum, and continuing until the formation of mature pollen grains; and secondly, a female or ovule phase, commencing with the growth of the ovules and continuing until the formation of mature embryo sacs. This development of male and female tissues in successive phases is the normal arrangement in hermaphrodite flowers, the interval between the two reduction divisions being constant for any given species, the variations between different species being correlated with the amount of ovular development therein.

In the flowers of a 'female' plant of *R. acris* the male and female phases coincide completely, the reduction divisions in anthers and ovules commencing at the same time. The two processes are not able, apparently, to proceed concurrently, and complete failure of the tapetum in the anthers is probably due to lack of sufficient food supplies reaching them from the main axis.

Several of the forms of *R. acris* intermediate between 'normal hermaphrodite' and 'female' were also examined, and there was found to be a direct correlation between the extent of overlap of male and female phases on one hand, and the amount of good pollen produced on the other. In each case the commencement of growth in the ovules was associated with the sudden failure of the tapetum in the anthers of the same flower, with cessation of pollen development as a sequel.

It is conceivable that this time factor will explain the occurrence of complete and partial diœcism in many species; in those plants where all grades from staminate to pistillate flowers are found, there are indications that the appearance of partial or complete 'male' forms, with a corresponding sterility of the ovules, may be explained by variations in the vascular structure of the flowers under consideration.

A detailed account of the influence of this time factor in *R. acris* and some other species is being prepared for publication.

R. O. WHYTE.

Botany School,
Cambridge.

Floating Mercury on Water.

WHILE trying, recently, a process for cleaning mercury, I obtained some small globules floating on water, in the same way that a waxed needle floats. The mercury had been shaken with sulphuric and chromic acids, and was finely subdivided; on pouring carefully into water, a few globules floated. Some of these ran together and coalesced, in deep depressions in the surface; the largest floating globule was about 0·5 millimetre diameter. The flotation was quite

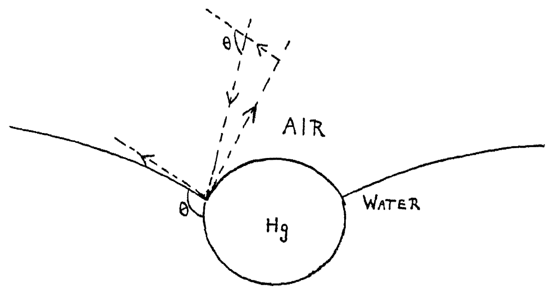

FIG. 1.

stable, and was not destroyed even by contaminating the surface with a drop of oleic acid, which spreads to a film reducing the surface tension to about 46 dynes per centimetre. The accompanying rough sketch (Fig. 1) shows the directions of the relevant surface tensions dotted in.

The tensions of clean mercury against air (475 dynes per centimetre) and against water (375) differ by more than the surface tension of clean water, so that it would be impossible for clean mercury to float on water; the water would spread over the whole drop with zero contact angle. It is, however, well known not to be easy to get mercury clean enough for water to spread on it. The condition of flotation is that the contact angle, θ, should be definite, and for stable flotation it should be large. The mercury-air tension must be reduced to well within 46 dynes per centimetre of the mercury-water tension, for flotation on the surface contaminated by oleic acid. Since the mercury had been emulsified in the mixed acids, probably even the mercury-water tension had been a good deal reduced; therefore the mercury-air tension seems to have been reduced by an amount of the order one or two hundred dynes per centimetre.

I have never seen a description of the floating of mercury, and should be interested to hear if there is any record of it, or if anyone else has observed it.

N. K. ADAM.

The University,
Sheffield, Feb. 12.

The Electric Moment of Primary Alcohols.

OF late the question of the permanent dipole moment of polyatomic molecules has been considered of great importance in order to elucidate the nature of forces that interact between the constituent atoms of the molecules.

The electric moments of a number of primary and secondary alcohols have been determined in this

laboratory by Mr. P. C. Mahanti and Mr. R. N. Das Gupta with the Nernst bridge method, and the results clearly indicate that, so far as the *primary* alcohols are concerned, they have practically the same dipole moment in them.

Substance.	Chemical Formula.	$\mu \times 10^{18}$.	Observers.
1. Methyl alcohol .	CH_3OH	1·64 1·61	F.W.[1] J.[2]
2. Ethyl ,, .	C_2H_5OH	1·64 1·63	F.W. W.[3]
3. Propyl ,, .	C_3H_7OH	1·66	F.W.
4. Butyl ,, .	C_4H_9OH	1·65 1·62	L.[4] M.D[5].
5. Hexyl ,, .	$C_6H_{13}OH$	1·64	,,
6. Octyl ,, .	$C_8H_{17}OH$	1·62	,,
7. Noxyl ,, .	$C_9H_{19}OH$	1·60	,,
8. Decyl ,, .	$C_{10}H_{21}OH$	1·63	,,
9. Duo-Decyl ,, .	$C_{12}H_{25}OH$	1·62	,,
10. Benzyl ,, .	C_6H_5OH	1 66	W.
11. Iso-propyl alcohol	$CH_3CH(OH)CH_3$	1·78	M.D.
12. Iso-Butyl ,,	$(CH_3)_2CH . CH_2(OH)$	1 79 1·72	,, L.
13. Iso-Amyl ,, .	$(CH_3)_2CH . CH_2CH_2OH$	1·82 ? 1 76 1·85 ?	M.D. L W.

[1] F.W. Falckenberg and H. Weigt.
[2] J. M. Jona.
[3] W. J. W. Williams.
[4] L. Luise Lange.
[5] M.D. P. C. Mahanti and R. N. Das Gupta.

Since these alcohols are produced by the substitution of one atom of hydrogen by an OH-group in the normal hydrocarbon molecules, it is reasonable to infer that the dipole moment is due to the polarisation of the oxygen atom by the hydrogen atom on one hand and by the carbon atom on the other. In other words, it may be stated that the binding forces acting on the carbon atom reacting with the oxygen are just the same whether the chain is long or short, open or closed. It may also be pointed out that the carbon atoms associated with the CH group forming the iso-alcohols have quite different binding forces leading to different values of the permanent dipole moments. The details of the investigation will be published elsewhere.

P. N. GHOSH.

Applied Physics Laboratory,
University College of Science,
92 Upper Circular Road, Calcutta.

Action between Copper Salts and Glycerol.

A VIGOROUS action occurs when a solution of any of the copper salts (hydrated or dehydrated) in glycerol is heated to about 150° to 200° C.

The salts, with the exception of cupric chloride, are invariably decomposed into metallic copper (fine powder more than 99 per cent pure) and free acid, which may also undergo further decomposition. The decomposition products of glycerol are ethyl alcohol, acrolein (when the salt acts as a dehydrating agent), carbon dioxide, methane, carbon monoxide, and hydrogen, the last two being present only in small quantities.

With cupric chloride instead of metallic copper a white precipitate of crystalline cuprous chloride is obtained. This may be regarded as due to a secondary action set up in presence of copper, hydrochloric acid, and cupric chloride which is still in solution. The action seems to be fairly general, as other polyhydroxy alcohols (glycol, erythritol, and mannitol) give nearly the same result.

It is known (Sabatier and Gaudion, *Compt. rend.*, **166**, 1033-1039; 1918) that glycerol vapour is decomposed into almost the same products mentioned above, at 330° C., in presence of finely divided copper. It is very likely, therefore, that in the present case a proportion at least of the decomposition products are due to the catalytic action of copper.

If, as is generally believed, metallic salts dissolve in polyhydroxy compounds, replacing the hydrogen of the hydroxyl group by the metal, copper and glycerol would form a compound of the formula: $C_6H_{10}O_6Cu_3$. Further, as copper, carbon dioxide, and methane are the chief products of the reaction a possible way of explaining it would be: $C_6H_{10}O_6Cu_3 = 3Cu + 3CO_2 + CH_4 + C_2H_6$, although there is no direct evidence of ethane.

Apart from the theoretical considerations the reaction gives a method for preparing pure, finely divided copper, which is very suitable for catalytic purposes. Even crude copper sulphate yields quite a good product. The method may be also employed for preparing cuprous chloride from cupric chloride, the reduction being quantitative.

A detailed paper on the subject will be published shortly.

B. K. VAIDYA.

The University, Liverpool.

Effect of Electric and Magnetic Fields on the Helium Spectrum.

(BY IMPERIAL WIRELESS SERVICES.)

WITH a nearly uniform magnetic field of fifteen thousand gauss perpendicular to an electric field which varies from zero to fifteen thousand volts per centimetre, I find many lines which are not ordinary Stark components and appear not to be due to impurities. Effects are similar in the corresponding parhelium and orthohelium line groups near the diffuse series lines. For example, strong lines appear on the violet side of 4388 A. and 4026 A. at distances nearly double those of the usual fundamental combination lines of the Stark effect. These well-defined lines show no decided polarisation, and at maximum field are displaced toward the red 0·5 A. and 0·2 A. respectively. At an intermediate value of electric field, components in 4026 group are displaced from the diffuse line 0·25 A., 0·47 A., 0·62 A., 0·78 A., 1·90 A., 2·10 A. The components in positions of usual Stark components of large displacements are relatively diffuse.

That new lines should appear in the presence of crossed fields was first stated by Prof. Bohr. It is now possible to make repeated observations on these, owing to experimental features which will be described in a later paper.

In this research, I have been assisted by Dr. Chalk through a grant from the National Research Council of Canada.

J. S. FOSTER.

McGill University,
Montreal, Mar. 10.

Band Spectrum of Chlorine or Hydrogen Chloride.

FURTHER investigation of the bands described by me in NATURE of Jan. 19, p. 86, leaves no doubt that these were caused by traces of sulphur introduced into the stream of hydrogen by the sulphuric acid wash bottle. They are very similar to the bands described by Johansen (*Zeit. wiss. Photographie*, **11**, 20; 1913).

E. B. LUDLAM.

University Chemical Laboratory,
Edinburgh, Mar. 1.

The Transvaal Fossil Human Skeleton.

By Dr. ROBERT BROOM, F.R.S.

AT the end of January last a road party, working in the Springbok Flats about eighty miles north of Pretoria, in excavating calcareous ground to make a road, came across a human skeleton and bones of the extinct buffalo (*Bubalus Bainii*) and of a large antelope. The spot where the bones were found has been visited by Mr. C. J. Swierstra of the Transvaal Museum and Mr. Herbert Lang, and they have taken careful observations of the occurrence. There is a foot and a half of dark reddish-brown surface soil, with below it about six feet of calcareous tufa (Fig. 1). The skeleton was obtained at a depth of three feet from the surface and thus about one and a half feet from the top of the tufa. The bones are for the most part much impregnated with lime and, except the powerful long bones, badly broken. The skull is mostly broken into pieces about the size of half a crown or smaller, but fortunately the mandible is well preserved. In the opinion of Mr. Lang, the man has probably been killed while hunting and his body crushed in the mud by the trampling of a wounded buffalo—not improbably the one whose bones lay near his own. Mr. Swierstra has kindly asked me to make an examination and report on these bones.

The fitting together of the cranial fragments has been a matter of some difficulty, as at present about a quarter of the fragments are missing, and most are so impregnated with lime that it is difficult getting them sufficiently cleaned to fit nicely. Still, enough has been done to give a satisfactory idea of the shape and general character of the skull.

The Transvaal Museum is at present at work going over all the ground to endeavour to obtain all the missing fragments. As this will take a considerable time and will not alter materially any conclusion that can now be come to with regard to the skull, there seems nothing to be gained by delaying, more especially as the press has been largely interested in the matter and has been issuing reports, some of which are not altogether correct.

At present we have almost the complete right side of the skull and much of the left side, but without the basicranial region; and the whole of the face except the frontals and malars is lost. The mandible is practically complete. Of the post-cranial skeleton there are remains of three vertebræ and fragments of many ribs, a fragment of one scapula, half of one clavicle, both humeri but with the ends lost, much of both radii and ulnæ, and much of one hand. There is no trace of the pelvis or sacrum, but both femora are well preserved except that the ends are lost, and there is much of both tibiæ and parts of the fibulæ, with a well-preserved astragalus.

The skull is of the modern type with a fairly large brain. The maximum length is about 195 mm. and the breadth is about 144 mm. The antero-posterior measurement can be relied on as very nearly accurate, but the breadth is less certain, as the fragments of the left side of the skull cannot at present be fitted together, but the greater part of the occiput and frontales are preserved, and the middle line can thus be approximated. The cephalic index is thus about 74. The frontal region slopes, as seen on the photograph (Fig. 2), and is not in the least Neanderthaloid. The frontal bone is narrow, the width at the lower part being about 106 mm. The parietal region is lower than in most modern types of man, and there are no marked parietal eminences. The bones are not unduly thick—the maximum being less than 9 mm.

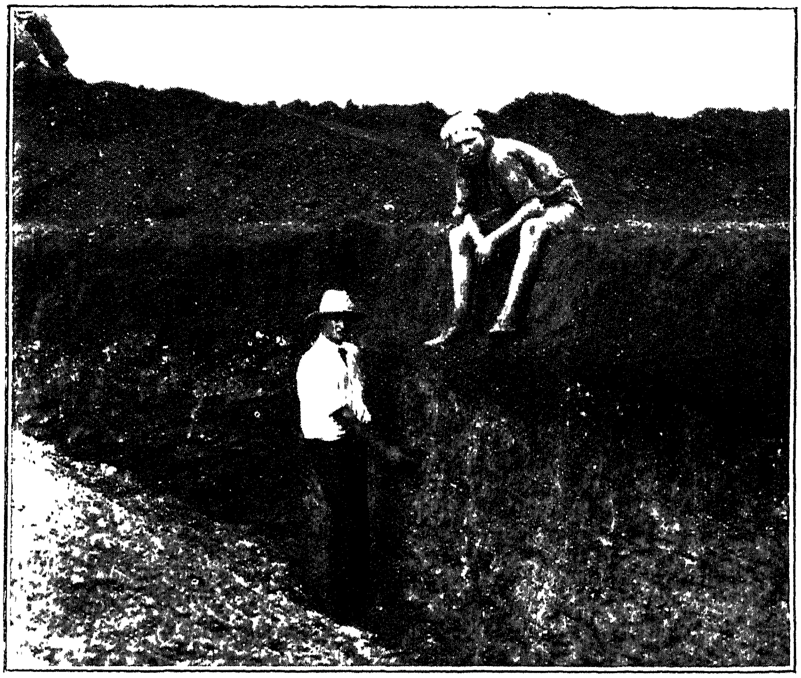

FIG. 1.—The quarry where the human remains were found. Mr. Miller, who discovered the remains, is pointing to the layer in the tufa where the bones were found.

The mandible is unusually long and very massive, and there is a well-marked chin (Fig. 3). The ascending ramus is very wide, being 48·5 mm. from the front of the coronoid process to the hollow below the condyle. From the condyle to the front of the symphysis is about 141 mm. The symphysis is 17·5 mm. in thickness. The teeth are

relatively small, the three molars measuring only 30 mm. and the molars and premolars together 42 mm. The crowns are badly worn down, and the pattern cannot with certainty be determined. There seems, however, to be no clear evidence of a 5th cusp, except perhaps in m'. The under side of the symphysis resembles considerably that of Neanderthal man. The angle of the jaw is extremely thick (7-8·5 mm.) and has prominent muscular ridges.

The limb bones are large and powerful. I estimate the humerus to be about 330 mm. long, but as both ends are lost it is impossible to give the measurements quite accurately. The radius, ulna, and phalanges are all those of a powerfully built man.

The femur can be restored with much probability, only the head and the distal end being unknown. There is considerable resemblance to the thigh bone associated with the Rhodesia skull. The bone is very long and massive ; the greatest length is, as near as may be, 500 mm. The shaft measures below the lesser trochanter 36 mm. by 28 mm. The shaft is very considerably curved. The tibia is about 435 mm. in length, and the shaft near the nutrient foramen measures 40 mm. by 30 mm.

A comparison with previously known prehistoric human skulls at once suggests a possible affinity with that of Cro-Magnon man ; and with the previously known large-brained South African fossil type, the Boskop man. The present skull, which may be referred to as the " Bushveld skull," resembles both in being large brained and in having a fairly good forehead and quite small supraorbital ridges. The man was also like that of Cro-Magnon,

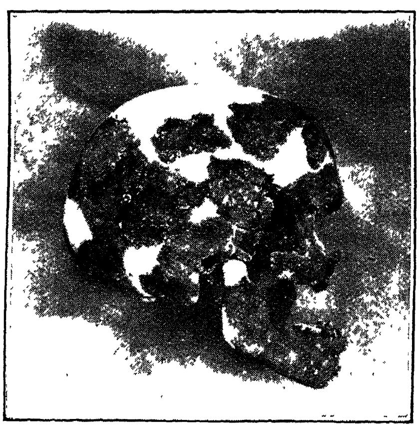

FIG 2.—Skull of Bushveld man as restored by R. Broom.

of large stature. But there are some points of striking difference. Cro-Magnon man had a high parietal region : Bushveld man has, like the Hottentots and Bushmen, a relatively low parietal region. This is a point to which most anthropologists pay little attention, but it is in my opinion one of very great importance. Lowness of the parietal region is evidently a primitive character. It is found in *Pithecanthropus*, *Eoanthropus*, Neanderthal man, Rhodesian man, and in Boskop man and in the Bushman of to-day. In Cro-Magnon man, as in most living races, the parietal region is high. There are many other striking points of difference, though possibly Cro-magnon man may be descended from a Bushveld-like type.

Boskop man also has some points of likeness. Both have low parietal regions, but there are few

FIG. 3.—Under side of jaw of Bushveld man with jaws of a Kaffir and a Hottentot for comparison.

other resemblances. Boskop man has prominent parietal eminences : Bushveld man has not. Boskop man has parietals 15 mm. in thickness. The skull of the Bushveld man is nowhere more than 9 mm. The teeth of Boskop man have apparently been large : those of Bushveld man are small. The bones of the Boskop man are much more completely mineralised and probably older, but until a good skull is obtained it will be impossible with certainty to fix its position.

The Bushveld man was certainly the contemporary of the extinct *Bubalus Bainii*. At Hagenstad, in the Orange Free State, we have many human implements in association with the bones of not only *B. Bainii* but also of the extinct *Equus capensis* and of two large extinct antelopes. We are thus probably justified in assuming that the Bushveld man was a member of the race that made the Hagenstad type of implements. These implements, according to the archæologists, are regarded as representative of the middle old stone age of South Africa, and we may thus regard the Bushveld man as the man of the middle Palæolithic period. Of course, at present we are quite unable to date the remains in years. We can only say that they are certainly very old.

There are many reasons for regarding the Korannas, a few of whom still survive in South Africa, as the direct descendants of the Bushveld type of man. For many years I have regarded the Korannas as one of the most important of the surviving races, though hitherto anthropologists have given them very little consideration. From the enormous numbers of implements found in the diamond gravels there must have been a powerful race, numbering tens if not hundreds of thousands, inhabiting the Vaal River valley in prehistoric times. This Bushveld skeleton is the first evidence we have of a man that probably belonged to this race, and it is interesting to find how closely he agrees in many respects with the surviving Korannas of to-day.

Chemiluminescence.[1]

By Dr. ERIC K. RIDEAL.

IN attempting to make the subject matter of this discourse as experimental as possible, it will be impossible to delve in great detail into the molecular mechanism of the reactions. This, I think, is as well, because many of the reactions which should be shown on account of their great beauty are certainly extremely complicated and have not, in fact, been subjected to any but a very superficial examination.

Chemiluminescence may be regarded as the counterpart of photochemical processes. By the absorption of light of suitable frequencies, atoms and molecules may be raised to states of higher initial energy. These excited entities may now undergo a series of changes, the nature of which will depend on a variety of circumstances. They may liberate their absorbed energy in the form of fluorescent light, impart part or all of their energy to a neighbour of another species by a collision, become converted into a metastable more permanent and energy-rich molecule which may afterward revert to the normal form, or suffer some species of chemical reaction such as ionisation, dissociation, or combination.

By suitable modification of conditions one can affect the velocities of chemical reactions over relatively wide ranges, and it is found that in many strongly exothermic reactions there exists a narrow range of relatively high velocities which is chemiluminescent. Closer examination indicates that practically all these reactions are complex in that they are accompanied not only by the emission of radiation localised in some portion of the spectrum but also by a rise in temperature. It is by a study of the chemiluminescent portion of such composite reactions that we may hope to gain a further insight into the molecular mechanism and the operation of the process of chemical activation.

We may with some degree of assurance assume that chemiluminescence is in many cases the result of liberation of chemical energy in a form similar to that of fluorescent energy, and we have noted that fluorescence is the result of decay of a number of excited molecules, the excitation being produced in this case by the absorption of radiation. Thus conditions suitable for chemiluminescence result in reactions in which large numbers of excited molecules are produced by chemical reaction, under conditions such that at least a fraction of the excited molecules can revert to the normal form with the emission of radiation. Excluding thermally accelerated exothermic reactions, a large group of auto accelerating reactions exhibit chemiluminescence; these are usually designated as branching chain reactions, and we shall observe that there are several hypotheses as to the nature of such reactions and at least two distinct light-producing processes.

A typical reaction of this type is the oxidation of phosphorus—one of the oldest chemiluminescent reactions observed with a definite substance, although the chemiluminescence of fireflies, decaying wood and certain bacteria and fish have long been commented on and were formerly attributed to the action of vital forces. The name phosphorus arose from a confusion of chemiluminescence with the phosphorescence of the impure barium sulphide, the so-called lapis Bologniensis. We may symbolise the fact that the reactions proceed in branching chains in a number of ways: thus, denoting the reactants by A_2 and B_2 and the molecules in the excited state by A'_2 we might postulate as the mechanism

$$
\begin{aligned}
(a)\quad & A'_2 + B_2 \rightarrow A'_2B_2 \rightarrow (A'B)_2 \rightarrow AB' + AB' \\
& AB' + A_2 \rightarrow AB + A'_2 \\
(b)\quad & A_2 + B_2 \rightarrow AB + A + B \\
& A + B_2 \rightarrow AB + B \\
& B + A_2 \rightarrow AB + A
\end{aligned}
$$

In both cases the conditions that one elementary reaction shall produce at least two reacting molecules so as to effect an auto accelerated reaction are fulfilled, but whilst in the first the chemiluminescence is imagined to result from the return of the excited species AB' or A'_2 to the normal, in the second it is supposed to take place through some type of atomic combination; for example, $2A \rightarrow A_2$ or $A + B \rightarrow AB$, a mechanism which has been more fully investigated in a series of reactions which will be discussed later.

We may note that, in addition to these types of chain mechanism, there exists a third in which it is imagined that a certain number of reaction centres are formed, by some identified as ions; around these reaction centres reaction takes place and more reaction centres are formed. As a hypothetical case we might imagine that in a hydrogen chlorine mixture a positive ion is formed, and around this ion a number of hydrogen and chlorine molecules are held by electrostatic forces. On neutralisation of the ion, the energy set free effects the combination of the small group of molecules around the ion and chemiluminescence and the formation of a few more ions result.

That in the oxidation of phosphorus, sulphur, and probably many other substances, the chemiluminescence is the result of some such type of chain mechanism can scarcely be doubted, but it is difficult in fact to state to which of these three possible types any one reaction definitely belongs. It is perhaps significant that in the oxidation of phosphorus a number of the lines in the complex band spectrum of the emitted light are identical with those of ionised oxygen. A typical phenomenon observable in the chain or cluster reactions is that of inhibition by small quantities of inhibitors. We may note the ease with which inhibitors such as benzene and ether inhibit the glow of phosphorus, a confirmation of the nature of the chemical process at work. Many other vapours exhibit chemiluminescence on oxidation, a fact noted by Sir Humphry Davy; thus the vapours of ether and carbon disulphide can readily be caused to undergo cold luminous combustion. Under more restricted

[1] From a lecture, with experiments, delivered at the Royal Institution on Friday, Feb. 15.

conditions, the union of acetylene and chlorine and the oxidation of the hydrocarbons can be made to exhibit chemiluminescence, and although in these reactions the thermal changes are relatively large, yet since the light emitted is definitely chemiluminescent, it seems almost certain that, contrary to the views of several investigators in these reactions, one cannot be dealing exclusively with thermally accelerated as opposed to branching chain or cluster accelerated reactions; excited molecules, atoms, or reactive clusters must be taking part in the reaction.

Far more complicated, but equally beautiful, are a number of chemiluminescent reactions taking place in solution. The well-known Wedekind reaction, the interaction of chlorpicrin and phenyl magnesium iodide exhibiting a green chemiluminescence, requires the use of a draught chamber, but the cold oxidation of pyrogallol formaldehyde mixture exhibiting an orange-red light, due to Trautz and Schorigin, blue luminescence in the oxidation of 3-aminophthalic hydrazide and the green of triphenyl glyoxalin (Lophin) are all brilliant and readily demonstrated. These reactions are characterised by a high temperature coefficient—some 2-3 for a rise of 10° C.—an indication of the chemical origin of the light-emitting system.

It is somewhat remarkable that few people have observed the beautiful chemiluminescence exhibited by the interaction of chlorine or chromyl chloride with ammonia, although I suppose the former reaction is demonstrated annually in at least one of the classes in every school where chemistry is taught.

Sir James Dewar noted a chemiluminescence when ozone is brought into contact with organic matter. Such chemiluminescence is particularly marked in the oxidation of certain dyestuffs both fluorescent and non-fluorescent; we may observe the phenomenon in a brilliant form in the case of alcoholic solution of both eosin and safranin. The chemiluminescent light is not identical with the fluorescent light of these dyes. This reaction may be modified so as to give a very vivid demonstration of the action of inhibitors. By addition of a small quantity of hydroquinine to the alcoholic solution of safranin we note that on exposure to ozone no chemiluminescence results, the dyestuff is not oxidised, but after a minute or two the hydroquinine is completely oxidised and the brilliant green glow of the dyestuff undergoing oxidation spreads over the bulb.

We have already indicated the possible connexion between chemiluminescence and reversed photochemical action, postulating in both cases the generation of an excited molecule formed in the former by chemical and in the latter by radiant processes. This analogy may be pursued somewhat further by a consideration of the mechanism of photochemical sensitisation and its reversal. In cases of photochemical sensitisation, a molecule excited by the absorption of radiation conveys by collision part or all of its energy to a molecule of another species which afterwards undergoes chemical reaction. The beautiful experiments of Franck and Cario in forming chemically reactive hydrogen by sensitisation with mercury vapour excited by the line $\lambda 2537{\cdot}4$ A. may be cited as a case of photochemical sensitisation. A similar complementary reaction in chemiluminescence has been observed by Kautsky, who showed that the energy liberated as chemiluminescence in the oxidation of the suboxide of silicon, siloxene, could be transferred to certain dyestuffs causing them to become excited and undergoing fluorescence. Only those dyestuffs such as fluorescein and eosine which are adsorbed by the crystals of the siloxene can be made to fluoresce, an indication that the energy necessary for excitation of the dyestuff molecule must be transmitted by collision from one of the surface molecules of the solid reacting siloxene, which in turn must pass through the stage of an excited molecule during oxidation.

The experiments initiated by Haber and Zisch on the interaction of the alkali metals with halogens and halides have more recently been re-examined by numerous investigators, notably Kondratjew, Ljalikoff, and Polanyi; these all exhibit beautiful chemiluminescent effects. The interaction of sodium and iodine vapour and of potassium and iodine demonstrate the various phenomena to be observed in these reactions, and analysis of the radiation, as well as of the distribution on the tube walls of the salt formed, gives us a clue to the mechanism of the reaction. In the interaction of sodium vapour and iodine we may compute the thermal changes accompanying all the possible reactions.

$$
\begin{aligned}
&(1)\ \mathrm{Na} + \mathrm{I_2} = \mathrm{NaI} + \mathrm{I} + 33{\cdot}5\\
&(2)\ \mathrm{Na} + \mathrm{I} = \mathrm{NaI} + 68{\cdot}7\\
&(3)\ \mathrm{Na_2} + \mathrm{I} = \mathrm{NaI} + \mathrm{Na} + 51\\
&(4)\ \mathrm{I} + \mathrm{I} = \mathrm{I_2} + 35{\cdot}2
\end{aligned}
$$

It is observed that the *D* line only is emitted, corresponding to a chemiluminescent emission of 48·3 cal. Of the four reactions listed above, only two are accompanied with sufficient energy for the liberation of the *D* line, namely, (2) and (3). A further observation that the chemiluminescence possesses in this case a negative temperature coefficient, suggests that only one of these reactions, namely, $\mathrm{Na_2} + \mathrm{I} = \mathrm{NaI} + \mathrm{Na}$, is responsible for the chemiluminescence observed in the gas phase, and that neither (2) nor (4) takes place in the gas phase except in a reaction more involved than a bimolecular one. The tube walls catalyse both reactions (2) and (4) effectively. The surface catalysed reaction is clearly observed in the union of potassium and iodine, for the reaction (3) above does not occur to an appreciable extent when sodium is replaced by potassium on account of the low concentration of diatomic potassium molecules in the vapour of the element.

The bulk chemiluminescent processes can accordingly be represented as

$$
\begin{aligned}
&\mathrm{Na_2} + \mathrm{I} \rightarrow \mathrm{NaI'} + \mathrm{Na}\\
&\mathrm{NaI'} + \mathrm{Na} \rightarrow \mathrm{Na'} + \mathrm{NaI}\\
&\mathrm{Na'} \rightarrow \mathrm{Na} + h\nu
\end{aligned}
$$

Chemiluminescent methods may be employed not only to identify as noted above the nature of

the molecular processes involved in a chemical reaction, but also to fix, within certain limits at least, the energy of dissociation of certain gases. Thus, the simple dissociation process,

$$H_2 \rightleftarrows 2H,$$

in reality must be much more complicated in operation than the unimolecular bimolecular dynamic equilibrium postulated by this equation given in the text-books. Whilst the efficiency of collision in causing reaction of complex molecules such as $2NO_2 \rightleftarrows N_2O_4$ is usually high, that of atomic recombination is very low, and if we regard a pair of normal atoms in close proximity to one another as the extreme case of dissociation, the absence of an electric moment in the system forbids the quantised emission of radiation. Thus reactions such as $2H \rightarrow H_2$, $2Br \rightarrow Br_2$, only occur in the presence of a third body or a surface, and the energy of combination transmitted to the third body is frequently emitted as chemiluminescence, a phenomenon readily observed with atomic hydrogen. The energy of combination of atomic hydrogen is found to be sufficiently great to excite the OH molecule to emission, but not the mercury line $\lambda 2537$ A. in mercury atoms; this places the energy of dissociation of hydrogen between 94,000 and 112,000 cal. per gram molecule.

Atomic hydrogen, readily prepared by Wood's method, is a convenient source of many chemiluminescent experiments. The afterglow of a number of gases, notably oxygen, nitrogen dioxide and nitrogen, when excited by the electric discharge, may all be regarded as chemiluminescent reactions in that the gases possess enhanced chemical reactivity in the glowing state. The glow of nitrogen dioxide and nitric oxide and the afterglow of Lord Rayleigh's active nitrogen are particularly brilliant, but the chemical processes involved are at present obscure. It seems at least definitely established that active nitrogen contains at least two chemically reactive species, both atoms and excited molecules. The cohesion of solid surfaces may be regarded as a species of chemical reaction in the solid state, and several of these reactions are found to be chemiluminescent; although frequently classified as tribo- or crystaloluminescent reactions, the crystallisation of arsenious oxide and sugar exemplify this class of reaction.

Other quasi-chemical reactions which are luminescent include the fluorescence and phosphorescence excited in various substances, especially in solid solutions, by electron bombardment, some of the effects produced by the bombardment of minerals such as kunzite by high speed electrons being particularly brilliant. Finally, we may observe the chemiluminescence obtained with certain bacteria such as *B. fluorescens* and the reaction between luciferin and luciferase, the basis of biological light.

Obituary.

MR. S. S. BUCKMAN.

THE son of Prof. James Buckman, a well-known botanist and geologist of his day, Sydney Savory Buckman, born in 1860, early followed in his father's footsteps. His attention was particularly directed to the Brachiopoda and Ammonites of the Inferior Oolite, and so early as 1883 he contributed a paper on the former to the *Proceedings of the Dorsetshire Natural History Field Club*. Buckman will, however, be chiefly remembered for his work in connexion with the Ammonites, which he showed could be used as zone fossils for subdividing the Jurassic strata. His study of these was extensive, and a monograph of those from the "Inferior Oolite Series" (never really completed) formed one of the Monographs of the Palæontographical Society (1887–1907), while he further traced their evolution through the successive strata, and in so doing was led to create a multitude of genera and species far beyond what had hitherto been deemed necessary.

In connexion with all this work and subsidiary to it, Buckman published very many papers and memoirs on the classification of Ammonites and Brachiopods. When his connexion with the Palæontographical Society was severed, Buckman began in 1909 a work on "Yorkshire Type Ammonites," consisting of photographic figures of the types accompanied by the original descriptions. This was carried on until his eyesight failed six months ago. The geological structure of the Inferior Oolite also received his attention, and he traced foldings in the beds that in some cases corresponded with those known to exist in the underlying Palæozoic rocks, thus bearing out Godwin-Austen's principle of the continuity of folding with its economic consequences.

The physical geography of south-western England was the subject of a paper (*Natural Science*, 1899) far too little consulted by later writers, in which Buckman treated of the "Development of Rivers; and particularly the Genesis of the Severn." The capture of the headwaters of the Thames by the Severn has, perhaps, never been better set forth. Buckman's extensive and original work became absorbed to such an extent into contemporary geological thought that few of the younger generation of geologists realise how much they owe to him.

The value of Buckman's labours was recognised by the Geological Society, of which he was elected a fellow in 1882, by the award of the Murchison Fund in 1897, of the Lyell Fund in 1903, and the bestowal of the Lyell Medal in 1913. His researches stimulated many a geologist, and not in England alone, to a more detailed study of the rocks and their fossil contents, and all such he was ever ready to help in the most unselfish way. His death on Feb. 26 last was greatly regretted by all privileged to know him, and his memory will be cherished as one of the kindest of men.

DR. DU RICHE PRELLER.

DR. C. S. DU RICHE PRELLER died at his residence in Edinburgh on Feb. 17 in his eighty-fifth year. He was a notable representative of a type of which the numbers are steadily growing less, to the great loss of the community. A successful professional man, with varied interests rising naturally out of the practice of his profession, he superimposed upon those interests others which in the course of his long life led to his appearing to include most branches of knowledge within his sphere.

By training an engineer, Dr. Preller's technical training was supplemented by wide studies in pure science, carried out in French and German universities as well as in Yorkshire. His active career was spent mostly on the Continent, where he was engaged especially in railway and electrical undertakings in Germany, Italy, and Switzerland, being at one time chairman and chief engineer of the Limmat valley electric railway. He was also interested in the lighthouses of the French coast. From his absorption in hydro-electric installations there arose naturally an interest in problems of glacial geology and of mountain form and structure generally. Again, an inborn aptitude for languages—he belonged to a Huguenot family long settled in England—combined with long residence on the Continent, made him an excellent linguist; he spoke and read easily French, German, Italian, and Spanish. He had also a great love of music, art, and literature, while travel was another favourite recreation.

Though Dr. Preller collected together a number of studies on the geology of Italy in a book published in three volumes as "Italian Mountain Geology" (1918–23), for which the Royal University of Florence made him an honorary doctor of science, most of his scientific writings took the form of essays, papers, and letters contributed to technical, scientific, and other periodicals. He was an occasional contributor to NATURE, but many of the papers of his later years, after his settlement in Edinburgh in 1912, appeared in the *Scottish Geographical Magazine*. These dealt with a great variety of subjects, including the old problem of Hannibal's route across the Alps. With interests so widely diffused great originality was not to be expected, and accuracy in detail at times left something to be desired; but for these qualities we look to the specialists. The great importance of such men as Dr. Preller is that they act as liaison officers between the educated public and scientific specialists. Their steadily decreasing numbers is to be regretted in that the specialists are always tending to become more and more unintelligible even to their fellows in other branches.

WE regret to record the death of Dr. Humphrey Purnell Blackmore, widely known as an archæologist, which took place at Salisbury on Feb. 2, at the age of ninety-three years. He was educated at Queenwood College and qualified in medicine at the earliest possible age. While in practice at Salisbury he took up the study of geology. The results of his intimate study of local conditions were published in the Geological Survey account of Wiltshire. He contributed to the Blackmore Museum, which was founded by his brother, a valuable series of palæontological remains which he himself had discovered in the local gravels. When the Salisbury and South Wilts Museum was founded, now more than sixty years ago, it was very largely due to his activities, and he took a very considerable share in determining its methods and arrangement. His interests in archæology were wide, and brought him into intimate touch with the most prominent archæologists of his day, among the more noteworthy being Sir John Evans, Sir Augustus Franks, Lord Avebury, and Sir William Boyd Dawkins. Although to a later generation he was more widely known by name than personally, he was always ready to throw open the valuable collections in his house at Salisbury to research workers. With his death, and that of Sir William Boyd Dawkins, has finally passed away that generation of pioneers which founded British prehistoric archæology and raised it to the foremost place in the study of the culture of early man.

THE death is announced of Dr. Joseph Goldberger on Jan. 17. According to a *Daily Science News Bulletin* (Science Service, Washington, D.C.) he was born in Austria in 1874, and at the age of six emigrated with his parents to the United States. Twenty years later he joined the U.S. Public Health Service and soon afterwards was attached to the Hygienic Laboratory, Washington. His greatest contributions to science were his studies on the nature, cure, and prevention of pellagra, which he determined to be a food-deficiency disease dependent upon lack of fresh and proper proteins. He discovered that yeast is a preventive in the absence of fresh meat and milk. He also contributed studies on yellow fever, dengue, measles, and influenza.

WE regret to announce the following deaths:

Mr. Edward Davidson, for many years secretary and treasurer of the Royal English Arboricultural Society, on Mar. 4.

Dr. Alex Hill, secretary of the Universities Bureau of the British Empire and formerly Master of Downing College, Cambridge, and Principal of University College, Southampton, on Feb. 27, aged seventy-two years.

Mr. John Hyde, from 1897 until 1905 chief of the bureau of statistics of the U.S. Department of Agriculture, known also for his work on the economic effects of disease, food and population, etc., on Jan. 18, aged eighty years.

Dr. Frederic A. Lucas, director of the American Museum of Natural History from 1911 until 1923 and since honorary director, and a foreign member of the Zoological Society of London, on Jan. 9, aged seventy-six years.

Sir John Denison Denison-Pender, G.B.E., K.C.M.G., chairman of the Eastern and Associated Cable Companies, on Mar. 6, aged seventy-three years.

News and Views.

ON p. 415 of this issue we publish the first authoritative account to reach England of the skeleton discovered in January last in the Springbok Flats, Transvaal. The discovery has already been announced in cabled dispatches appearing in the English press, but the detailed account of the circumstances of its discovery and the results of the examination of the skeletal remains which Dr. Broom now gives make it possible to form a more adequate estimate of its importance. Its chief point of interest is that not only is the skull that of modern man, but it bears a close resemblance to the Cro-Magnon type of the European upper palæolithic age. In this it agrees with the Boskop skull; but another feature which it has in common with that skull and in which they both differ from the Cro-Magnon is, that while the latter is high, they are both low. This is important, as by some the Boskop skull was thought to have suffered from post-mortem deformation. The long bones of the new skeleton, though much broken, by the estimate of their length would bear out the resemblance to Cro-Magnon man in point of being large. The Bushveld skull, as Dr. Broom suggests the new find should be called, resembles the Boskop skull in that the eyebrow ridges are not prominent and both are large-brained. Although not so long as the Boskop skull, to which an estimated length of 210 mm. was given, the Bushveld skull measures 195 mm. This, on an estimated breadth of about 144 mm., gives a cephalic index of 74. Although, as Dr. Broom points out, the new skull differs from the Boskop skull in several particulars, it confirms the evidence of the earlier find of the existence in South Africa of an early large-brained race. But, whereas the Boskop skull was regarded as showing affinities with no existing race in South Africa, Dr. Broom is inclined to see in the Korannas the descendants of Bushveld man.

THE suggested correlation of the Bushveld man with the middle palæolithic of South Africa, through the association of the remains with an extinct species of buffalo also found in association with the Hagenstad type of stone implement, adds considerably to the interest and importance of the find. This may be still further enhanced when it is possible to bring it more closely into relation with the investigations which Mr. Leakey is carrying out in Kenya, where it is evident from the communication which appeared in the *Times* on Mar. 7 that finds of a crucial character are possible at any moment. The discoveries of this season which Mr. Leakey announces are of a sufficiently surprising nature. In last season's excavations at Elmenteita a Mousterian layer had been reached below the Aurignacian level in the cave known as Gamble's Cave II. This year, two occupation levels with industries of typical Aurignacian facies have been found below the Mousterian horizon, belonging to the same Second Pluvial period as that horizon. This sequence has been confirmed at a number of sites. As there is no evidence of any mingling of the Mousterian and Aurignacian industries, it can only be concluded that the Mousterian in East Africa represents an actual racial intrusion and not merely a cultural influence, while, further, the reversal of the sequence normal in Europe points to the immigration of a race from outside into an area in which the Aurignacian was either the indigenous culture or, at any rate, in which it was sufficiently near its place of origin to permit of its earlier penetration. This is what might be expected on the view of the African origin of the Aurignacian culture. Two skeletons have been discovered which agree with previous discoveries in associating *Homo sapiens* with Aurignacian industries. Mr. Leakey, holding that any human remains discovered in association with the Mousterian industry will be of the Neanderthal type, suggests that such remains may link up man in East Africa with Rhodesian man.

THE centenary of King's College directs attention to an educational institution which has the distinction of being one of London's oldest colleges and the misfortune of being one of the poorest. It is the worst-endowed College in Great Britain, and yet the numbers of students have doubled since the War, and the high standard both of its teaching and research is being steadily maintained. While the appeal for £350,000 which has been launched is wide, in that it embraces the improvement of buildings, the provision of endowments, scholarships, and bursaries, there is one particular aspect which we would recommend to our readers. The College has always occupied a leading place in its work for scientific progress. It was the first English college to establish either a physics or a bacteriological laboratory. The work done in the physics and electrical departments is particularly distinctive. Wheatstone invented the telegraph; Maxwell disclosed the principle to which broadcasting owes its origin; while in more recent times Prof. O. W. Richardson formulated the laws underlying the action of wireless valve filaments. Important wireless research is at present being pursued by Prof. E. V. Appleton.

THE electrical industry is largely indebted to work carried on at King's College. The theory of the parallel running of electrical alternators as used to-day in all the large power stations, and the invention of the three-wire system of supply, were first propounded by Prof. John Hopkinson. The present professor of electrical engineering, Prof. Ernest Wilson, has carried out important investigations on the corrosion of metals such as are used for overhead wires and are exposed to the London atmosphere. Neither the physics nor the electrical engineering departments has an endowment income. They are almost entirely dependent upon a fluctuating student fee income. It is now proposed to raise a sum of £50,000 to endow chairs in these two departments. The amount is modest enough in comparison with the wealth of the wireless and electrical industries, and donations to either branch of the College would be a recognition of indebtedness and an encouragement for future

research. Donations may be sent either direct to King's College, Strand, W.C.2, or to the College bankers, Messrs. Coutts and Co., 440 Strand, W.C.2.

AT the South Africa meeting of the British Association in July next, the Council will nominate Dr. F. O. Bower, F.R.S., lately Regius professor of botany in the University of Glasgow, as president of the Association for the year 1930, when the meeting will be held in Bristol. The Association has received from the Court of Common Council (the Corporation of the City of London) the expression of a hope that London will be selected as the place of meeting in the centenary year, 1931, and offering entertainment to the Association in that event. This invitation has been accepted, and the centenary meeting will therefore be the first ever held in London.

IN view of the importance of the wool industry to South Africa, it is fitting that wool research should be a strong feature at the meetings of the British Association this year. Among those who have already signified their intention of being present are Prof. Aldred F. Barker, head of the Textile Department of the University of Leeds; Dr. S. G. Barker, Director of Research of the British Research Association for the Woollen and Worsted Industries, and Dr. J. E. Nichols, also of the Research Association, who is at present engaged on a sheep and wool survey of the British Empire. Principal H. Richardson, head of the Technical College, Bradford, is also expected to attend. Dr. J. E. Duerden, Director of Wool Research of the Union of South Africa, will give an account of the wool investigations in progress in the South African Department of Agriculture, and others will deal with various nutritional and genetical experiments. Mr. E. N. S. Warren, head of the Sheep and Wool Section at the Grootfontein School of Agriculture, will describe the instructional course given there, which is admitted to be one of the foremost in the world.

THE inauguration of a television broadcasting service in Great Britain is at present being considered by the Post Office officials. Great progress has recently been made at the Baird laboratories and very satisfactory demonstrations of land line transmissions have been given on a 'televisor.' It is quite easy to 'tune in' the picture by one control and 'frame' it correctly by the other control. The pictures are still somewhat limited in size, but excellent 'head and shoulders' reproductions are given, and in conjunction with a loud speaker give a very interesting performance. Considerable detail is given in the picture—the time, for example, on the performer's watch can be easily read. A high tension pressure of 350 volts is required for the home televisor, but if an alternating current lighting supply is available, this can be readily obtained by an 'eliminator.' At present the sets are designed for a fixed wave-length of 200 metres (1500 kilocycles). It is, perhaps, too early to say what is the narrowest band of frequencies that is necessary to transmit a sufficiently satisfactory picture. In the event of the establishment of a television broadcasting service, it would be advisable to have as narrow a band as possible so as to avoid interference with the ordinary broadcasting and other services. Everything depends on how much flicker and lack of detail can be permitted without appreciably detracting from the pleasure of the 'looker-on.' Television for the theatre seems to be an easier problem than television for the home. As this would be worked throughout by experts, the large performance factor of safety required for home sets would be unnecessary.

IN every continental area the number of wave-lengths available for broadcasting is strictly limited. The radiation from an aerial may be considered as made up of rays parallel to the surface of the earth and of rays inclined to the surface. The latter radiations suffer very little attenuation, and, striking the conducting layer, get bent down towards the earth and sometimes produce interference with parallel waves. Such interference has been noticed between stations 2000 miles apart. In a paper by P. P. Eckersley and A. B. Howe, read to the Institution of Electrical Engineers on Mar. 6, a method of getting over interference difficulties by using the same wave-length for several stations is discussed. Three other methods have been suggested. The first is by securing a proper international agreement between the nations, the second by designing all transmitting aerials so that only radiations parallel to the earth's surface are emitted, and the third by using only a few high-powered stations instead of many low-power stations. Most broadcasting authorities throughout the world are adopting the third of these methods. In 1924, Captain Eckersley suggested in addition that several broadcasting stations in each country might be operated on the same wave-length. At the present time Edinburgh, Hull, Bradford, and Bournemouth share the same wave-length with satisfactory results. The case of Bradford is interesting, as it is only about 60 miles from Hull. When Bradford shared a wave-length with other European stations the good service range was only about half a mile from the aerial. Now, although it has the same wave-length as Hull, it has a good service range exceeding five miles. The chief sphere of usefulness of this new method is to bring first-class service to isolated towns. Low-powered stations and short wave-lengths would be used, as all the regional high-power stations need long wave-lengths. The method should appreciably relieve the broadcasting conditions in Europe.

THE Institute of Metals, founded for the study of Non-Ferrous Metallurgy in 1908, which has just held its twenty-first annual meeting, had an initial membership of about 250. To-day the roll of its members exceeds 2000, of whom about two-thirds are British and Empire members, while the remaining one-third consists of foreign members. At the time of its formation many doubts were expressed whether such an institute could be formed and maintained, and whether it would fulfil any really useful function. When the successful career of the Iron and Steel Institute was cited as an encouraging example, the doubters pointed out that the non-ferrous industries were much smaller, less wealthy, and less advanced

from a technical and scientific point of view. It was even feared that manufacturers might not wish to support such an institute and that they would decline to allow the members of their staffs to take part in its meetings for fear of divulging confidential information. Fortunately, the small band of enthusiastic founders of the Institute did not permit themselves to be deterred by such misgivings, and as soon as a start had been made it became abundantly clear that a real need existed for an institute dealing with the non-ferrous metals. From the very beginning the Institute prospered. Its membership began to grow steadily and still continues to increase to-day, while the value of its work and influence stands fully recognised both in Great Britain and abroad. Its first three presidents were the late Sir William White, the late Sir Gerrard Muntz, and the late Prof. W. Gowland, representing respectively the user, the manufacturer, and the scientific student of metals. This order of rotation in filling the presidential chair has been followed, with a few exceptions in special circumstances, throughout the past history of the Institute. It is intended to emphasise the fact that the Institute seeks to serve the interests of all those directly concerned with the non-ferrous metals, whether as users, manufacturers, or scientific investigators and teachers of metallurgy.

A PROVISIONAL notice of the forthcoming International Congress of Forestry Experimental Stations, to be held at Stockholm and elsewhere next July, has already appeared in NATURE (Dec. 1, 1928, p. 852). The sessions of the Congress will take place in Stockholm during the week July 22–27, an excursion being paid during the week to visit forests at Noorköping and Katrineholm. Although the deliberations of the Congress are confined to a week, the programme laid down is more comprehensive. Two extensive tours, one in the south and the other in central and north central Sweden, are projected, each covering eight days, during which a considerable part of the country will be traversed. Those members wishing to participate in the first tour will assemble at Malmö on July 14, arriving at Stockholm on July 20. During this period interesting forests will be visited at Dalby, Furen, Bokenäs, Malingsbo, Siljansfors, and in the region of Siljan and Domnarvet. A number of private forests (pine, spruce, and beech) will be visited on this southern tour. Also the pine and spruce State forests of Malingsbo in Dalarna, where the College of Forestry has instructional forests; and the experimental forests of Siljansfors, which are under the management of the Experimental Station and in which research work is undertaken. This excursion will conclude with a trip through the beautiful country round Lake Siljan, when the rafting in the Daläven River will be seen and a visit paid to the town of Falun, an ancient ore-mining and forest industries centre.

THE second excursion which has been arranged for the International Congress of Forestry Experimental Stations will prove of even higher interest. Members will leave Stockholm for Bispgärden on July 28 and will visit forests and forest industrial works at Kulbäckstiden, Svartberget, Lycksele, Hoting, Frösön to Åre, situated in the highlands of Jämtland, where amongst other things of interest the wonderful waterfall of Tännforsen will be viewed. The intention of the northern tour is to demonstrate the forestry problems of Norrland and the difficulties incurred in slow-growing northern forests with a more or less sterile soil. Rafting and the industrial side of forest work in Sweden, which is of such great importance to the commercial well-being of the country, will be seen. The programme laid down for this Congress is extensive and can scarcely fail to be productive of work of importance to forestry science, whilst the members will have an opportunity of becoming acquainted with some valuable aspects of Swedish forestry methods.

THE following were elected fellows of the Royal Society of Edinburgh at a meeting held on Mar. 4: Dr. S. G. Barker, director of research, British Research Association for the Woollen and Worsted Industries, Leeds; Dr. F. Bath, lecturer in mathematics, University of St. Andrews; Mr. G. Bennet, lecturer in mechanical engineering, Heriot-Watt College, Edinburgh; Dr. A. Calder, assistant in the Animal Breeding Research Department, University, Edinburgh; Dr. G. Coull, pharmaceutical chemist, of Leith; Prof. E. W. H. Cruickshank, Physiology Department, Dalhousie University, Halifax, Nova Scotia; Mr. D. Kennedy Fraser, psychologist to the Education Authority, Glasgow; Mr. T. Henderson, actuary of the Savings Bank of Glasgow; Dr. Sunder Lal Hora, senior assistant superintendent, Zoological Survey of India, Calcutta; Prof. J. Kendall, Chemistry Department, University of Edinburgh; Mr. J. R. Little, general manager and secretary of the Century Insurance Co., Edinburgh; Prof. D. N. M'Arthur, Department of Agricultural Chemistry, West of Scotland Agricultural College, Glasgow; Mr. J. Mackie, mathematical master, Leith Academy, Leith; Mr. W. Mercer, lecturer in clinical surgery, University of Edinburgh; Mr. H. Moir, president, United States Life Insurance Co., in the City of New York; Prof. F. W. Ogilvie, Department of Political Economy, University of Edinburgh; Dr. J. F. V. Phillips, botanist, Tanganyika Territory; Mr. S. Read, Edinburgh Academy; Mr. R. A. Robb, lecturer in mathematics, University of Glasgow; Principal J. C. Smail, Heriot-Watt College, Edinburgh; Prof. Sydney Smith, Department of Forensic Medicine, University of Edinburgh; Dr. T. Southwell, lecturer in helminthology, School of Tropical Medicine, Liverpool; Mr. A. C. Stephen, assistant, Natural History Department, Royal Scottish Museum, Edinburgh; Dr. B. P. Wiesner, lecturer in sex physiology, University of Edinburgh.

THE United States Bureau of Mines has issued its report upon coal production in 1926. It consists, as usual, of numerous detailed statistical tables, whilst there is also much interesting information explaining the changes from year to year in the statistics quoted. The greater part of the report is interesting only to coal workers in the United States, but there are some passages which coal producers, and especially coal miners in Great Britain, would do well to take to

heart. Thus the report states that "The foreign demand was unusually intense because of the seven months' suspension of production in Great Britain. The general walkout of the British miners on May 1 immediately started discussion of exports from this country." "A gain of approximately 14,000,000 net tons of shipment to Europe represented the greater part of the growth in the sea-borne trade in 1926. This coal displaced former British tonnage in the main and went chiefly to the United Kingdom, Irish Free State, Italy, and France."

ENGINEERS engaged in designing will be interested to know that Messrs. Adam Hilger, Ltd., are now making Prof. Coker's well-known apparatus for the study of the stresses in engineering structures by means of the double refraction which stresses produce in transparent models, and the effect this double refraction has on either plane or circularly polarised light passing through them. Models of celluloid, stressed in their own planes, are used up to 3 inches long. In circularly polarised light the areas of maximum stress are immediately apparent, and for many purposes this will be sufficient for the engineer. If the actual magnitudes and directions of the principal stresses at each point are required, a more detailed examination under plane polarised light and with an auxiliary sheet of the same celluloid in simple tension used as a standard of stress is necessary.

IT has well been said that the aspiration after the understanding of human nature and human actions is the key to much that is characteristic of the present century. It is beginning to be realised that science is the new humanism, and that industrial aspects of it have to be considered not merely as profitable enterprises but also in relation to social welfare. We therefore welcome the announcement of the publication of a new monthly magazine—*The Realist*—which will aim at presenting contacts of scientific discovery and other forms of creative expression with social, economic, and political affairs of the modern world. The magazine has a strong editorial board representative of many fields of progressive thought and action, and it should make a wide appeal to intelligent citizens who seek something more substantial than they usually find in journals devoted to literary and political trivialities. The first number is to appear on Mar. 26, and will be issued by Messrs. Macmillan and Co., Ltd., for the Realist Publishing Co., 25 Victoria Street, S.W.1.

THE Torquay Natural History Society shows satisfactory progress. In spite of the fact that the building of an extension to the Museum interfered with the ordinary course of museum work, a varied programme of twenty-two lectures was carried through. The addition of a second storey to the museum has permitted the exhibition of a loan collection of ethnographical specimens and of much material formerly stored away. The activities of the Society are carried on by a series of sections with specialised interests, the most lively being the archæological, the botanical, and the entomological. In each of these, papers of general and local interest were read, and some of these have been published in the *Transactions*.

THE Report of the Museums of the Brooklyn Institute of Arts and Sciences for 1927 gives a great impression of activity and progress, not only in the field of exhibition pure and simple, but also in many side activities aiming at the education of the student and the people in general. The Department of Natural History has been given much additional room for expansion, many new galleries, three of which have been converted into European period rooms, have been opened, a large annex has been adapted for the Children's Museum at a cost of some £10,000, and a lunch and tea room has been created. The energy of the staff is indicated by the fact that ten special exhibitions of various art collections and eight exhibitions of prints were held in the course of the year. Special educational activities include the institution of a press for printing lithographs for the use of students, the formation of a class in clay modelling for children in the elementary schools, the exhibition of motion picture films portraying the "Chronicles of America," and zoological subjects (purchased from Raymond L. Ditmars) for school children, as well as lecture courses for the public, for teachers, and for students. The Children's Museum, with its loan exhibits of natural history specimens, its school visits helped by three teachers assigned by the education authorities, its summer field trips, and many other activities, ought to instil the scientific mood at a period when it is most likely to have a telling influence. The cost of running these excellent museums during the year was roughly £43,000 for the Central Museum, and £4700 for the Children's Museum.

THE G. J. Symons Memorial Lecture of the Royal Meteorological Society will be delivered on Mar. 20, at 7.30 P.M., by Mr. R. A. Watson Watt, who will take as his subject "Weather and Wireless."

DR. L. F. HEWITT has been appointed bio-chemist at the Metropolitan Asylums Board's antitoxin establishment, Belmont Laboratories, Sutton, Surrey. Dr. Hewitt is at present Gibbons Research Fellow at the London Hospital; and was formerly research chemist, Medical Research Council, Mount Vernon, Hampstead.

A VIOLENT earthquake was recorded at Kew Observatory on Mar. 7. The first tremors reached the observatory at 1 hr. 46 min. 36 sec. G.M.T. The distance of the epicentre is estimated at 5400 miles, and the bearing is 7° W. of N., corresponding with a position near the Aleutian Islands, lat. 50° N., long. 168° W.

AN additional evening meeting of the Royal Geographical Society will be held on Monday, Mar. 25, at 8.30 P.M., at the Polytechnic Theatre, Regent Street, when Sir Douglas Mawson will give an account of recent work on the fjords of New Zealand and will show the kinematograph film of his Antarctic Expedition of 1911–1914, not before shown in England in its final form.

MAJOR H. O. D. SEGRAVE established a new speed record on Mar. 11 at Daytona Beach, Florida, with an average of 231·36226 miles an hour. Major Segrave was driving his Irving Special racing car *Golden Arrow*,

and covered the mile course in each direction at just over 231 miles an hour. The *Golden Arrow* has a 12 cylinder Napier-Lion engine which develops 930 h.p. and is not supercharged; the body of the car consists of three stream-line forms. The previous highest speed, 207·55 miles an hour, was attained by Mr. Ray Keech driving Mr. J. M. White's Triplex car on April 22, 1928.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant veterinary inspector under the Surrey County Council—The Clerk of the County Council, County Hall, Kingston-upon-Thames (Mar. 20). A lecturer in electrical engineering at the Rugby College of Technology and Arts—The Organiser of Further Education in Rugby, 61 Clifton Road, Rugby (Mar. 20). A head of the Mathematics Department and organising assistant to the Principal of Leeds Technical College—The Director of Education, Education Department, Calverley Street, Leeds (Mar. 23). An assistant lecturer in botany in the University of Bristol—The Secretary, The University, Bristol (Mar. 25). A deputy curator of the Sunderland Public Libraries, Museum, and Art Gallery—The Chairman of the Libraries, Museum, and Art Gallery Committee, Town Hall, Sunderland (Mar. 25). A lecturer in physics at the Chelsea Polytechnic—The Principal, Chelsea Polytechnic, Manresa Road, S.W.3 (Mar. 28). A demonstrator for laboratory work in physics and electrical engineering at the Royal Naval Engineering College, Keyham (Plymouth)—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (Mar. 31). A head of the pharmacy department of the Leicester College of Technology—The Registrar, College of Technology, Leicester (April 3). A lecturer in the Department of Mining of the Imperial College of Science and Technology—Prof. S. J. Truscott, Imperial College of Science and Technology—Royal School of Mines, South Kensington, S.W.7 (April 15). A professor of biochemistry in the University of Alberta—The Secretary of the Board of Governors, University of Alberta, Edmonton, Alberta, Canada (May 14). A junior chemical assistant to the Research Association of British Flour Millers—The Director of Research of the Association, Old London Road, St. Albans. A senior science mistress at the County School for Girls, Beckenham—The Head Mistress, County School for Girls, Beckenham. A bacteriologist in the Malayan Medical Service—The Private Secretary (Appointments), Colonial Office, 2 Richmond Terrace, S.W.1.

Our Astronomical Column.

TWO NAKED-EYE SUNSPOTS.—Two groups of sunspots, large enough to be seen with the naked eye, have recently been on the sun's disc at the same time. The larger of these was a stream, with a big composite leader spot, crossing the central meridian on Mar. 11. It was the return or revival of a group in the previous rotation with central meridian passage on Feb. 12.

The second group consisted of a single spot, fairly regular in outline, and showing bright projections partly across the umbra; there were small companion spots and a subsidiary stream southwards. The following table gives other details of the two groups:

No.	Date on Disc.	Central Meridian Passage.	Latitude.	Area
3	Mar. 2–14	Mar. 8·3	7° S.	1/2000
4	Mar. 5–17	Mar. 11·0	10° S.	1/800

(Areas express proportion of hemisphere covered.)

CHANGES IN THE EARTH'S ROTATION.—A paper by the Astronomer Royal and Mr. R. T. Cullen was read at the meeting of the Royal Astronomical Society on Mar. 8, in which the residuals in longitude of the sun for the last 150 years were compared with those for the moon. It was found that a much greater accordance was produced by deducing the sun's longitude from the observed Declinations in the neighbourhood of each equinox, than by deducing it from the Right Ascensions. The early observations of Right Ascension of the sun are affected by abnormal errors which do not enter into the Declinations to the same extent.

The new reduction leads to a much closer resemblance between the curves of solar and lunar residuals than has previously been obtained, and thus strengthens the hypothesis that the cause of these fluctuations lies in the earth's rotation, not in the bodies themselves.

MEASUREMENT OF STELLAR RADIATION.—The recent considerable advances made by Pettit and Nicholson in the knowledge of stellar radiation has been made possible largely through the great 100-inch Hooker telescope, combined with the extremely delicate thermocouples and refined methods of measurement introduced by these two pioneers. Their latest results are given in the *Astrophysical Journal*, vol. 68, p. 279, which includes an interesting account of the construction of the thermocouple. This delicate operation, in which wires of about 0·03 mm. are used, has to be performed under a microscope, and the resulting thermocouples are capable of measuring radiometric magnitudes with an uncertainty of only 0·1 of a magnitude. A discussion of the observing methods used and the reduction of the observations is followed by the results obtained for the 124 stars so far observed. These are reduced to a homogeneous system of radiometric magnitudes, heat indices, and water-cell absorptions, corresponding to the standard conditions of (1) the star in zenith, (2) two reflections from fresh silver, and (3) a rock-salt window in thermocouple. The corrections required to reduce to no atmosphere and for the total radiation reaching our system are given, as well as the computed bolometric magnitudes.

DETONATING FIREBALL IN NEW ZEALAND.—There has been evidence of a widely awakened interest in astronomy of late years in New Zealand. One of the directions of its manifestation is the careful observation and discussion of meteors. Mr. R. A. McIntosh describes in *B.A.A.J.* for February a brilliant fireball that appeared over the Coromandel Peninsula (North Island) on the night of Oct. 27, 1928. As the moon was full, and yet the object was so conspicuous, the magnitude is estimated as -15; the explosion was seen by three observers; the meteor separated into three or four portions, which quickly died out. The height at commencement was 75 miles, at the end 25 miles, the visible track being 107 miles long and the velocity 27 miles per second. The explosion shook the houses, and was heard over a large area. A faint trail was seen for 2½ seconds. The radiant was at 6° + 24°, near Alpha Andromedæ.

Research Items.

CLIMATE AND HEALTH.—The statistical relations between climatic factors and human health has been investigated by Dr. A. Wallen in a publication of the *Statens Meteorologisk-Hydrografiska Anstalt*, Bd. 5, No. 1, of Stockholm, entitled "Vädevlekens Samband med Hälsotillståndet." Dr. Wallen has studied the correlations between the mortality and health of Stockholm and Göteborg on one hand, and pressure, temperature, humidity, precipitation, and diurnal variation on the other. No particular relationship is found between pressure and health, but mortality increases during high pressure both in summer and winter. This, however, may be due rather to the associated high temperature in summer and low temperature in winter. A close relation appears to occur between temperature and health. Humidity also plays an important rôle. Dry seasons at all times of the year show an increase in the mortality rate, and winters and springs with a high humidity are also marked by a high mortality. No relation was traceable between the amount of precipitation and health or mortality. Considerable diurnal variations in temperature or in pressure show correlations with an increase in the mortality rate. Dr. Wallen also traces correlations between meteorological factors and the number of workmen on sick leave in a large factory with 1000 employees. A close correlation was shown in an increased number of cases during low barometric pressure. The paper contains a large number of graphs and statistical tables, and a useful bibliography of the subject.

HANDWRITING.—*Science Progress* for January has an article on experimental graphology by R. Saudek. Handwriting being a very personal activity, one would expect on *a priori* grounds that it would be possible to deduce from it something of the personality of the writer. Numerous attempts have certainly been made and while some people would seem to have had some success in individual cases, yet the scientific treatment of the subject is very recent. From the legal point of view the aim of the graphologist is to discover whether the questioned document is the work of the reputed writer, and, if it is not, to prove the identity of the handwriting in its inconspicuous characters with that of the suspected person. The assumption on which the expert relies is that the inconspicuous features of the handwriting cannot be consistently disguised in a manuscript of any length. The problem of the diagnosis of the character of the writer is more complicated. The writer of this article has subjected handwriting to a detailed analysis, and asserts that there are at least twelve factors that co-operate in the formation of the individual writing. These factors include the writing instruments, the degree of maturity of the writer, the acute physiological condition of the writer, and the speed of the act of writing, etc. Detailed explanations are given and specimens of handwriting illustrating the various points. The kinematograph has proved useful in distinguishing some of the laws. The research is interesting as marking a beginning of the study of this subject, though one is left with the feeling that much yet remains to be done.

WILD BIRDS AND DISEASE IN THE POULTRY YARD.—Various investigators have shown that a number of species of wild birds occasionally harbour a gape-worm identical with that which causes severe epidemics amongst poultry (*Syngamus trachea*). Odd records refer to the pheasant, thrush, magpie, jay, and jackdaw. A more serious infestation may occur in the starling, in which Lewis found that, in the Aberystwyth district, 169 out of 482 (35 per cent) carried the parasite. Charles Elton and Frank Buckland have now discovered that a much higher percentage of the rooks in the Oxford district are similarly affected (*Parasitology*, vol. 20, December 1928). The samples are small, but the results are striking: of eight adults examined, four contained gape-worms, and 31 out of 33 young rooks. Rooks and starlings are frequent visitors to the poultry yard, and the possibility that they may be responsible for the distribution of gape-worms amongst domestic fowls deserves immediate investigation. The very high incidence of the presence of gape-worms amongst young rooks may account in part for the mortality which they are known to suffer in the nest, and this also may be a factor of some economic importance.

PARASITIC WORMS OF THE WILLOW GROUSE.—A paper by Johan Huus (*Bergens Mus. Aarbog*, 1928) forms one of the contributions to the extensive investigation recently completed on the biology of the willow grouse in Norway. The alimentary tracts of 517 birds were examined and four species of worms obtained, namely, two nematodes—*Ascaridia compar*, *Capillaria longicollis*, and two cestodes—*Railletina urogalli* and *Weinlandia microps*. *Ascaridia compar* was found in the jejunum of 190 of the birds examined. A careful account is given of the morphology, the distribution and the biology of the worm. The larvæ of *Ascaris lumbricoides* and of *Ascaridia galli* are known to pass from the intestine into the blood stream and via the heart to the lungs, where they escape into the alveoli, and thence come into the trachea and pharynx, from which they pass into the stomach and intestine. The author believes that the larvæ of *Ascaridia compar* have a similar course, for the youngest examples found in the duodenum were 3 mm. long and were undergoing their last ecdysis. There is no evidence that this worm is pathogenic; the passage of the larvæ through the lungs, especially in young chicks, may be harmful. *Capillaria longicollis* was found only in three birds, in the duodenum. *Railletina urogalli* was present in the jejunum of 57 of the birds examined, and *Weinlandia microps* in the duodenum in 60 cases. The author points out that parasitic worms were not present in the cæcum of the birds examined.

RESEARCHES ON COPEPODS.—Mr. A. G. Lowndes, of Marlborough College, in continuation of his researches on freshwater copepods, has published two interesting papers, "Freshwater Copepoda from the New Hebrides" (*Annals and Magazine of Natural History*, Ser. 10, vol. 1, June 1928) and "The Result of Breeding Experiments and other Observations on *Cyclops vernalis* Fischer and *Cyclops robustus* G. O. Sars" (*Internat. Revue der ges. Hydrobiol. u. Hydrographie*, Bd. 21, Heft 3/4, 1928). The first of these deals with a collection of copepods made by Dr. J. R. Baker from a large lake on the Island of Gaua. The lake is more than 300 feet deep, the pH at the surface and middle layers was 8·5 and the temperature 25° C. Five species of copepods only were obtained, all but one well known and of wide distribution. It is very interesting to find that in the majority of cases little or no difference in structure is visible between the forms from the New Hebrides and those from the British Isles and elsewhere. No Calanoids were found in this collection. In a sample from Hog Harbour, Santo, *Cryptocyclops anninæ* occurred in abundance in empty coco-nut shells. In the second paper Mr. Lowndes describes the result of breeding together the two copepods *Cyclops vernalis* and *Cyclops robustus*, the object of the work being to decide whether *C. robustus*

should be regarded as a separate species or only as a variety of *C. vernalis*. The specific characters are based almost entirely on the spine formulæ and on the nature of the setæ. Mr. Lowndes has shown in previous breeding experiments on *Cyclops* that the spine formulæ may be exceedingly variable and too much importance must not be attached to these for the identification of species. The experiments were carefully carried out, and in addition cultures were made from the adult female of *C. robustus* which gave rise to *C. vernalis*. *C. vernalis* was successfully crossed with *C. robustus*. Both forms occur together in the same pond with every gradation between the two. It is concluded from these observations that *Cyclops robustus* is not a separate species, but only a form of *Cyclops vernalis*.

FISHES FROM FLORIDA AND THE WEST INDIES.—In the paper under this title (*Proceedings of the Academy of Natural Science of Philadelphia*, vol. 80; 1928), Mr. Henry W. Fowler reports on collections obtained in Florida, the Bahamas, Haiti, Porto Rico, Saint Lucia, and Dominica. The specimens, except the Porto Rican collection, are in the Academy of Natural Science of Philadelphia. Several hundred species are recorded, but none is new, although there are new localities for many of the fishes and some are specially interesting in their distribution. The author also mentions nineteen examples of *Rivulus hartii* (Boulenger) from Pitch Lake, in Trinidad, British West Indies, which were presented to the Academy by Dr. Judson Daland in April 1928. Some of the species from Florida are new to the United States fauna. These include a specimen of *Rivulus cylindraceus* Poey which is re-described. There are some rare fishes from the Bahamas. One specimen of *Sparisome radians*, 81 mm. long, was taken from the stomach of *Serranus striatus*. From Bermuda three examples of *Halichœres radiatus* are recorded and one of *Callyodon plumbeus*. A collection of 69 species come from Haiti, obtained by Mrs. James Bond in the Porto Prince market. Valuable colour notes are given for many of the fishes.

THE BLOOD OF INVERTEBRATES.—The holothurian *Caudina* is a favourite subject for physiological research, and is specially interesting, for not only is there hæmoglobin in its blood, but also this is contained in corpuscles, as Hogben recently described in a South African *Cucumaria*. Two papers in the *Science Reports of the Tôhoku Imperial University* (4th series (Biology), Sendai, Japan; vol. 3, No. 4, Fasc. 1; 1928) deal with the subject. In "Chemical Studies on Sex Differences of Blood Protein in *Caudina chilensis* J. Müller," Tetssutaro Tadokora and Shukichi Watonabe have followed up their researches on sex differences in the blood protein of mammals. They contend that similar differences are found in *Caudina*. Mr. Nobukuki Kawamoto ("Oxygen Capacity of the Blood of Certain Invertebrates which contain Hæmoglobin") uses the mollusc *Andara inflata* as well as *Caudina* for his experiments. Both contain hæmoglobin in the blood corpuscles, and the present work was undertaken in order to make a comparison with the blood of invertebrates having no hæmoglobin, such as those used recently by other workers (*Helix*, *Octopus*, *Homarus*, *Astacus*, *Cancer*). It is shown that compared with the higher Mammalia, the blood of *Andara* and *Caudina* absorb much less oxygen, but compared with the invertebrates quoted, the oxygen capacity is much greater. It is also greater that that of sea water.

EARLY HISTORY OF COTTON.—A. N. Gulati and A. J. Turner, of the Technological Laboratory of the Indian Central Cotton Committee, have an interesting note on the early history of cotton in *Bulletin* No. 17, Technological Series No 12, issued in October 1928 by this Committee. (The same paper appears in the *Journal of the Textile Institute*, **20**, pp. T1-T9, January 1929.) The earliest known mummy cloths in Egypt, according to Petrie, date from about 5500 B.C. and are made of flax. No Egyptian mummy cloths appear to have been made of cotton, but mummy cloths of cotton have been found in Peru, where one species of *Gossypium* seems to be indigenous. Recently, scraps of cotton material have been found amongst the remains of the prehistoric civilisation unearthed at Mohenjo-daro in Sind. These remains belong to the three latest cities erected on this site, which are ascribed to dates between 3500 B.C. and 2400 B.C. Messrs. Gulati and Turner have made as full an examination of this material as the condition of its preservation permits, and conclude that the cotton is not of the *G. herbaceum* type, but more closely related to the coarser fibres of the *G. arboreum* type. One sample of string found in earthenware had a purple colour; a few tests made on this sample suggested that the dyestuff originally employed was of the madder type.

ABACÁ, A LITTLE-KNOWN PHILIPPINE FIBRE.—The Cordage Institute of the United States has made possible a detailed study of the conditions of cultivation and production of 'abacá' fibre. This product is obtained from the outer, lower side of the long fleshy leaf stalks of *Musa textilis* Née, which overlap to form the main stem of this plant. The industry is indigenous to the Philippines, where the fibre has been known since Pigafettas' diary of Magellan's trip around the world (1519), in which the name first appears. A million or more bales of fibre from cultivated varieties of this plant are annually exported from the Philippines, whilst fibre is now also being produced from the same plant in Borneo, Java, and Sumatra. During recent years a scientific study of the crop and its product has been initiated, and the *Philippine Journal of Science*, Vol. 37, No. 1, Sept. 1928, contains a series of papers by P. L. Sherman, Cordage Institute Fellow, and his colleagues of the Bureau of Science, Manila, which give the first results of this work. These papers deal largely with the soil conditions and the state of the fibre as originally prepared. Active fermentation processes are at work in the soil owing to the mass of rotted vegetable material from the leaf debris left after cutting out the fibres; partly as a result, the extracted fibre is usually somewhat full of acid materials, and the writers point out that unless it is thoroughly dried before it leaves the collecting ground, there is great danger of rapid deterioration in storage.

FOSSIL OSTRACODA OF ITALY.—A monograph on the fossil Ostracoda of Italy has been begun by A. Neviani. The first part (*Mem. Pont. Accad. Sci. N. Lincei*, Ser. 2, vol. 2) treats of those from the classical beds of Vallebiaja, near Fauglia, which the author refers to the Lower Calabrian of Gignoux. Nearly 70 species are described, about 18 being considered new, and the details of their occurrences in time from the Mesozoic to the present day are set forth in tabular form. There is a good index and two excellent plates.

THE BUSHVELD COMPLEX OF THE TRANSVAAL.—Among the spectacular geological phenomena for which South Africa is becoming increasingly famous, the great body of igneous rocks known as the Bushveld complex occupies an impressive position. Molengraaf, Mellor, Hall, Wagner, du Toit, and other pioneers have already established its principal

features, and now a valuable summary appears from the able pen of Prof. R. A. Daly, accompanied by eighteen new analyses and a stimulating discussion of the kind which enlivens all his contributions to geological literature (*Bull. Geol. Soc. America*, vol. 39, pp. 703-768; 1928). This paper should be of special value to geologists attending the South Africa meeting of the British Association and the meeting of the International Geological Congress. Some of Daly's conclusions differ from the current interpretation of the Union Geological Survey. According to the latter, the Bushveld felsite is excluded from the complex and assigned to a Rooiberg series which is made the top of the Transvaal system. Daly thinks that the felsite is at least partly, and possibly wholly, a definite member of the complex, akin to the roof of the Duluth 'lopolith' which seems to have been in part its own extrusive phase, chilled against the atmosphere. It is also suggested that the coarse granites of the Complex are not contemporaneous throughout, but are made up of two main intrusions; one red, preceding the norite, and the other pink and slightly more mafic, succeeding the norite. It is recognised that the Complex will long furnish genetic problems of fundamental importance to geologists and petrologists. In this paper the difficult questions of magmatic origins are touched on but lightly.

Lapland Meteorology.—The observatory at Abisko, on Lake Torne in Swedish Lapland, has published its detailed observations for both 1926 and 1927. The headings to the tables are in Swedish and French. The usual meteorological data are given in full. In addition, there are a number of valuable records on the hydrology of the lake, including its weekly temperature at a depth of one metre, the dates of freezing and breaking up, and the thickness of the ice at weekly intervals during the long period from November to June, when the lake is frozen. Soil temperatures, on every fifth day throughout the year, are given for depths of 50, 100, 150, and 200 cm. There are also full notes on the displays of aurora borealis. These publications are valuable contributions to the study of Arctic Europe.

Automatic Level Gauge Alarm.—The application of photoelectric and selenium cells to operate alarms and automatic controls regulating the level of liquid in tanks and stand pipes is an interesting example of the growing industrial application of these instruments. The device is especially useful when the liquids are under high pressures, as then the standard methods of level control are inapplicable. The following simple arrangement is in use at the works at Billingham of the Synthetic Ammonia and Nitrates Limited. A glass inspection gauge is fitted at the required level on the stand pipe and the light sensitive relay is illuminated through the gauge. Using opaque liquids, the light is shut off when the liquid rises and the relay then operates an alarm signal. When transparent liquids are used, an opaque float in the gauge glass can be used to shut off the illumination when the liquid rises. Alternatively, the light sensitive relay and the light source may be mounted on the same side of the gauge glass and the relay illuminated by a beam reflected by total internal reflection at the inner surface of the glass. In this case reflection ceases when the liquid rises, the beam of light being refracted through the liquid. The latter method is convenient when flat gauge glass, to which a right angle prism can be cemented, is used.

Photosynthesis of Carbohydrates.—Prof. E. C. C. Baly's production of carbohydrates by the exposure to light of carbonic acid which had been deposited on the surface of nickel or cobalt carbonate, of which an account was given in the *Proceedings of the Royal Society* for 1927, has now been shown by him and N. R. Hood to show an additional resemblance to natural processes in its susceptibility to the influence of temperature (*ibid.*, A, vol. 122, p. 393, Feb. 4). The yield of carbohydrates in his experiments increases linearly with temperature to a maximum at 31°; photosynthesis by some algæ has been long known to obey a similar law, and it is now found that the temperature coefficients for the changes are almost the same in the two cases. Above 31°, the yield again decreases in his experiments, and becomes almost zero at about 48°; a botanical analogue of this is known in the existence of an optimum temperature for natural photosynthesis by leaves, with an assimilation-temperature curve which is very similar to that found by Prof. Baly, showing in particular a sharp peak at 37°. Prof. Baly has not discussed in any detail exactly what occurs in the purely physico-chemical processes with which he had been concerned, but it is evident from the similarities that he has pointed out that many of the characteristics of the natural phenomena are merely those of a pure photochemical surface reaction.

Transmutation of Elements.—In an X-ray tube there is a large localised dissipation of energy in the neighbourhood of the focus-spot, where the electrons are incident on the anode. If it were possible to bring about transmutation by moderate quantities of energy, conditions here would appear to be particularly favourable, and any positive results obtained would carry considerable weight, since the substance being studied remains in a high vacuum throughout the experiment, and is thus not liable to chance contamination. At the suggestion of Prof. R. A. Millikan, tests of this nature have been made by L. Thomassen in the Norman Bridge Laboratory at Pasadena. His results, which are described in the February issue of the *Physical Review*, are completely negative; no change was found in the characteristic X-ray spectrum of a tungsten target before and after the tube holding it had been operated for three days at a peak potential of 207 kilovolts and a current of a few milliamperes. The same author has also repeated the experiments of Prof. Smits, from which it appeared at one time that lead might be transmuted into mercury, and has obtained no evidence of change in a lead arc, and inconclusive results with a high potential discharge between lead electrodes immersed in carbon disulphide, his conclusions in the latter case being similar to those afterwards arrived at by Prof. Smits himself (see Nature, Jan. 2, 1926, p. 13, and Oct. 1, 1927, p. 475).

Photochemical Decomposition of Nitrogen Pentoxide.—The decomposition of nitrogen pentoxide in the presence of the dioxide, which photosensitises the reaction, using monochromatic radiation of wave-lengths 4350, 4050, and 3660 A., has been investigated by Baxter and Dickinson. Their results, which are described in the *Journal of the American Chemical Society* for January, appear to follow the mechanism suggested by Norrish. The first reaction is probably a decomposition of the dioxide into nitric oxide and oxygen. This is followed by a dark reaction between nitric oxide and nitrogen pentoxide: $NO + N_2O_5 = 3NO_2$. In the decomposition of nitrogen dioxide the quantum efficiency for radiation of wave-length 4350 A. is extremely low (0·0046 molecules of oxygen produced per quantum absorbed), and hence this wave-length should be ineffective for the decomposition of the pentoxide. This was actually found to be the case, since the effect with radiation 4350 A. was too small to be detected with the apparatus used.

The Eucalypts and Paper Pulp.

THE paper-pulp problem, especially with reference to what is termed newsprint or the material used by the daily press, is one of growing importance in many countries to those concerned. At first sight it would not, however, have been considered by the average man in Great Britain that the question had become one of importance in Australia ; yet it appears that, with an annual consumption of 120,000 tons of newsprint, Australia comes next to the United States of America and Canada on the basis of requirements per head of population. None of this paper is made in Australia, the reason given being that "existing processes of manufacture require light-coloured coniferous wood that can be readily converted into pulp by purely mechanical means." This ground wood or mechanical pulp comprises 70 to 80 per cent of the fibre-content of newsprint, the remainder being pulp from the same wood chemically prepared by the sulphite process and added to impart the necessary strength to the sheet.

This being the position, the problem which has to be solved before newsprint can be manufactured in Australia is the discovery of a substitute for mechanical pulp that will compare with it favourably in the quality of the paper, as also in price. The problem is no new one. In India, investigations in connexion with various bamboos and grasses have been carried out at the Forest Research Institute for nearly a score of years past. So far as quality goes, previous investigations in Australia (*Bulletin* No. 25, Council for Scientific and Industrial Research. Melbourne: H. J. Green) have shown that it was possible to produce from the eucalypts bleached soda pulp much superior in quality to ground wood, and the indications were that on a large scale this pulp could be made at a cost not very much above the latter. Experimental work in this matter had been carried out in connexion with the mountain ash (*E. regnans*), Victoria; stringy bark (*E. obliqua*), Tasmania; gumtop (*E. delegatensis*), Tasmania; beech (*Fagus Cunninghamii*), Tasmania; and *Pinus insignis*. This work was, however, considered to be too incomplete to be worth publishing. In connexion with *P. insignis* it has been shown that it makes excellent sulphite pulp, as well-grown *P. insignis*, of 15-20 years of age, carry only about the same amount of resin as spruce.

More detailed researches have since been undertaken by Messrs. L. R. Benjamin and J. L. Somerville ("Paper-Pulp and Cellulose from the Eucalypts by the Sulphite Process." *Bulletin* No. 37, 1928). This bulletin deals with the research work carried out during the last four years on the problem of applying the sulphite process to the pulping of eucalypts from the practical viewpoint and bearing in mind the limitations imposed by existing industrial equipment. The authors, in discussing their objective, remark :

"The precedence in point of time accorded the soda pulping investigations was based entirely upon the fact that the so-called ' hardwoods ' are seldom pulped by any other than alkaline processes. In this connexion it may be added that, by whichever process hardwood is pulped in other countries the product is almost invariably soft, bulky, and of low strength, its use being confined almost entirely to the manufacture of book papers in which the relatively high proportion of longer-fibred sulphite pulp from softwood is relied upon to impart the desired strength. In other words, hardwood pulp is used abroad as a filler for imparting softness and opacity. In *Bulletin* No. 25, previously referred to, it was shown, however, that pulp of good colour and high strength could be obtained from the eucalypts by a suitable modification of the soda process, followed by proper bleaching and heating. The experience thus gained has been of considerable value in the planning and conduct of the present investigation, one of the principal objects of which has been to find those cooking conditions that would give pulp possessing good strength and a colour sufficiently white, without bleaching, to be used, either alone or in high proportion, in the manufacture of newsprint. Other aspects have also been considered, such as the production of high-grade cellulose for use in the manufacture of artificial silk, but work in this direction has been restricted and mostly controlled by the necessity or desirability of acquiring evidence in support of certain trends, or of collecting incidental information that might be of value in establishing the proposed Australian newsprint industry."

The chemistry of the sulphite process, even at the present time, is incompletely understood, and there are many points connected with its application to the pulping of the eucalypts which the authors consider would well repay thorough investigation if the industry already existed in Australia, but they thought that for the present they should concentrate their investigations upon developing methods that would permit of ready application and be sufficiently economical to aid materially in the early establishment of the sulphite industry and the production of newsprint.

Those interested in this matter should consult this very interesting and valuable monograph. The authors' objects and results are expressed in the following :

"Preliminary investigations with the sulphite process pointed to the possibility of cheapening production to the required degree, and subsequent systematic study of the process has practically assured this, for it is now evident that bleaching can be eliminated and a pulp produced so much superior in quality to mechanical pulp, that the admixture of longer fibre for conversion into newsprint will probably not be necessary. Hence, as far as the production of a suitable substitute for mechanical pulp is concerned, the results of the present investigation indicate that this is entirely feasible.

"Apart from the demand for newsprint in this country, there is a large consumption of the better-grade printing papers and writing papers in which high-grade sulphite pulp is used. In addition to this there is a very heavy and increasing demand for artificial silk both in yarn and in the form of piece goods. These facts should stimulate the production of high-grade bleached cellulose once a newsprint industry relying on sulphite pulp is established. Accordingly, when it was found that the cooking conditions required for producing pulp sufficiently white in the unbleached state to be used in newsprint also closely approached those necessary for the production of high-grade cellulose, the opportunity was taken of exploring the possibilities further. As a result, considerable information on the physical qualities of the pulp, and the chemical purity of the cellulose produced in this investigation has been collected, and is now placed on record."

If this research work and experiments are translated into commercial operations, they should have an important outcome in the management of certain of the Australian forest areas. Their study will also repay countries in which the Eucalyptus has been successfully grown in plantations.

Natural History in Norfolk.

PROVINCIAL natural history societies may, and in many cases certainly do, perform very useful functions in keeping alive an active interest in Nature and the preservation of the local fauna and flora; but actual original work is generally confined to a small minority of members. Indeed, it is one of the chief difficulties in keeping such societies alive that the active members bear so small a proportion to the whole. A further difficulty exists when such societies also publish *Transactions*. On one hand, such a publication must, if it is to justify itself, maintain a certain standard of interest and originality; on the other, it is not advisable that it should be the medium of publication of original work of wide general interest, since the limited circulation of the journal makes it difficult of access, at all events in other countries. The papers published should deal primarily with the natural history, in its widest sense, of the locality, so the series of volumes should form a mine of trustworthy local information.

The Norfolk and Norwich Naturalists' Society has published its *Transactions* yearly, without a break, from its foundation in 1869, and has probably come as near as is possible to maintaining a general interest and value in its publications without going beyond its proper limitations. The part just published (vol. 12, part 4) opens with an account of the Mycetozoa by the president, Mr. H. J. Howard, illustrated by some remarkably fine photomicrographs, and including a complete list of the Norfolk species. Of the total of 121 species, Mr. Howard has added sixty to the county list, and among these one new to Britain and two varietal forms new to science. The paper should be of much value to anyone working at this group, by reason of the information given as to the nature of the habitat and season of appearance. A paper on the Swan Marks of East Norfolk, illustrated by figures of 160 of these marks, by Mr. Norman F. Ticehurst, embodies the results of an enormous amount of patient research and is of much more than purely local interest.

Prof. F. W. Oliver writes with his usual charm of a visit to Holland for the purpose of seeing the progress of experiments in reclamation by means of *Spartina Townsendi*. He has dealt with the subject in greater detail in other publications, but Norfolk has so much in common with Holland that what he has to say on this subject, and about the Nature reserves and flower culture in Holland, is of special interest to East Anglians.

A paper on the survey of Scolt Head Island by Mr. O. D. Kendall and Mr. J. A. Steers is a continuation of work intended to record the progressive changes in sand dunes and shingle banks due to tide and wind; two maps and a section illustrate the results of the survey.

Norfolk is fortunate in having the two National Trust properties of Blakeney Point and Scolt Head Island, both of which are being studied so effectively. Blakeney Point has already become famous from the work done by Prof. Oliver and his pupils, and at Scolt Head work on similar lines, under the supervision of Mr. Steers, is producing results of wide and permanent interest. The annual report of the Wild Birds Protection Fund again shows what excellent work in preservation of the local animal life can be done by provincial societies under the stimulus of an energetic personality. The Norfolk Wild Birds Protection Committee owes its existence to Dr. Long, and it is to him also that Norfolk owes the formation of the Norfolk Naturalists Trust, which owns a large area of marshes at Cley and intends to acquire other properties when the existence of rare birds seems likely to be threatened. The report includes some remarkable records of ducks shot at Hickling and Ranworth, those for the latter going back to 1920. From these figures it seems that the numbers of wildfowl are not, as has been supposed by some, on the decline.

The *Transactions* include also an article by Mr. Stuart Baker on the scientific results to be obtained by egg collecting, and a paper by Mr. Carruthers on planting at Scolt Head. The latter is of general interest, since much may be learnt from it as to the precautions to be taken in planting in such an exposed situation and on dunes.

The Storage of Food.

THE Report of the Food Investigation Board for 1927 [1] covers a wide range of problems connected with the subject of the storage of food, from purely scientific investigations to large-scale experiments on food transport and the necessary engineering practice. A considerable amount of work has been carried out on the transport and storage of fruit, especially apples, and on the changes taking place during storage which lead ultimately to its decay. Ships' holds are not airtight, leaks occurring through hatches or wooden bulkheads between holds; from the low percentage of carbon dioxide frequently found, it appears that at least one-third of the air present may be changed daily. Well riveted steel bulkheads, however, allow of little leakage. The question is of importance, both from the point of view of maintenance of a particular temperature in the hold, and also because the storage life of fruit depends in part on the composition of the surrounding air. The conduction of heat from the ship into insulated holds along frames and beams projecting into the insulation, and the heat generated by the fruit itself in storage, have also to be taken into account in the design of refrigerators. At 20° C. sound apples generate heat at the rate of about 0·012 cal. per sec. per kgm., or 0·0015 cal. per sec. for an individual apple; in other words, an apple in 23 hours would raise the temperature of an equal weight of water 1° C. if there were no heat loss. In practice the temperature in the centre of the store is taken by means of a distance reading thermometer, of which a number of types have been studied.

Numerous investigations have been carried out on the changes taking place in apples during storage and the factors influencing them. It has been found that the smallest fruit have the lowest respiratory activity, and that the maximal rise in this activity is smaller and later than in larger apples: at the same time, the smaller apples usually have the longest life. A low respiratory activity therefore delays the onset of internal breakdown in storage. The nature of the soil on which the fruit is grown has a definite effect on storage life: apples off a heavy soil keep twice as long at 34° F. as those off a light soil, whilst the keeping quality is also correlated with the 'available' potash and phosphoric acid in the soil. The nitrogen content of different kinds of apples tends to remain fairly constant; a higher nitrogen content is associated with a

[1] Department of Scientific and Industrial Research. Report of the Food Investigation Board for the year 1927. (London: H.M. Stationery Office, 1928.) 4*s*. net.

higher respiratory activity. The amount of sucrose and acid present, however, varies considerably from one type to another, and is also affected by the nature of the season: thus cold weather raises the acid content, at the same time decreasing the sucrose value, warm weather having the reverse effect. By such changes season can alter the keeping qualities of the fruit, since life depends on the presence of respirable material. During storage the sugar and acid disappear at a constant rate and breakdown occurs when the store of respirable material is exhausted. Gas storage also delays breakdown by slowing the respiratory processes, but just before death there is a sudden increase in the utilisation of sugar.

It has been found that the optimum temperature for gas storage is higher than that used for cold storage: by gas storage is meant an increase in the carbon-dioxide concentration above 5 per cent, with a corresponding decrease in the oxygen percentage. Gas storage at a low temperature in fact accelerates internal breakdown; but at a temperature above about 40° F. gas storage gives better results than cold storage alone. In addition to the internal breakdown which occurs at low temperatures, appearing, however, only after six to ten weeks' storage, there is another type of breakdown which is hastened by higher temperatures and occurs especially in imported apples: it can be avoided by gathering the fruit before a certain critical stage of maturity on the tree has been reached and its onset is definitely delayed by cold storage.

In addition to breakdown, fruit in store may be attacked by fungal disease: the resistance of the fruit depends on a variety of factors, such as acidity, water, nitrogen, and potassium content, and hence on the locality in which the fruit is grown. A low water and nitrogen content and a high acidity and potash content are associated with a high resistance; the converse is also true.

Another problem which has been investigated is the best method of bringing cold-stored produce back to a normal temperature: a rapid rise in air temperature leads to wetting of the fruit from condensation of water on its surface, since its temperature only rises slowly. Two methods of preventing wetting are available: a slow and uniform rise in temperature or drying of the air during warming: which may be the better depends on knowledge of the rate of evaporation from the fruit to be warmed, a problem which requires further investigation under practical conditions.

Further work has also been carried out during the year on meat and fish and their products. The conditioning of beef hung at a temperature of 41° F. has been studied: there is a progressive increase in tenderness especially noticeable in the coarser joints or in inferior quality carcasses, and even after 17 days the meat is still perfectly sweet.

It is now well known that, to obtain meat fit for consumption, freezing should be rapid to avoid the formation of large ice crystals: when the crystals are only small, on thawing the meat closely resembles fresh meat. It has now been found that bacon can similarly be frozen and be edible on thawing again, but the temperature necessary is considerably lower than that required for meat or pork. For pork, − 10° C. may be sufficient; but for mild cured bacon, − 15° C. at least is necessary for rapid freezing, the freezing point of the bacon being several degrees below that of pork. The practicability of freezing bacon at − 15° C. and then storing it at − 10° C. is now being examined.

Investigations of fish by-products have included the nutritive value of fish meals and the use of fish skins as a substitute for isinglass. It was found that seabream meal in the diet of pigs resulted in better growth than was given by the best white fish meal or blood meal and sterilised bone flour: moreover, the growth was made at a smaller expense in food than in the case of ordinary fish meal, a fact of considerable commercial importance. Similar results were obtained with rats, and the seabream meal also produced better calcification of the bones than white fish meal. The seabream is an oily fish which is not much used for human consumption. Work has also been carried out on the nature of the sterols in marine animals and on the constitution of squalene and certain of the higher alcohols, problems which may be found to have a bearing on the storage or use of the various products for human consumption.

University and Educational Intelligence.

CAMBRIDGE.—The Council of the Senate has presented a report to the University on an offer by the Medical Research Council to equip a Nutritional Laboratory on a site at the Field Laboratories, and has recommended that the offer be gratefully accepted.

LONDON.—The University College Committee will award in June next a Bayliss-Starling Memorial Scholarship of the value of about £120 (with exemption from tuition fees). Candidates may be graduates or undergraduates of approved standing in science or in medicine. The Scholar will be required to follow a course of study approved by the Jodrell professor of physiology involving a training in the principles and methods of research in physiology and/or biochemistry. Applications must be submitted on or before May 15, to the Secretary of University College, London (Gower Street, W.C.1).

A movement has been for some time in progress to endow the chair of engineering at University College in order to commemorate the great and enduring influence of the late Sir Alexander Kennedy on engineering education. This appeal has met with a wide response: nearly £19,000 has been raised of the £30,000 required. In a letter supporting the appeal, the presidents of the Royal Society and of the Institutions of Civil, Mechanical, and Electrical Engineers direct attention to Kennedy's pioneer work and the need of a permanent memorial. Subscriptions may be sent to Lord Meston, the Treasurer of this Fund, at University College.

MANCHESTER.—The University has received a bequest of £300 under the will of the late Miss Amy Henrietta Worswick. In accordance with the wishes of the testatrix, the bequest will be devoted to the investigation of the causes and treatment of rheumatoid arthritis. A temporary fellowship of the value of £150 per annum will be offered, and application may be made to the Registrar before Oct. 15 next by any person who has obtained a medical qualification registrable in Great Britain.

The University council has appointed Dr. D. R. Hartree, lecturer in mathematical physics at the Cavendish Laboratory, to the Beyer chair of applied mathematics in succession to Prof. E. A. Milne. Dr. Hartree was educated at Bedales School and at St. John's College, Cambridge, of which he was an entrance scholar. He took the Mathematical Tripos, Part I., in 1916, and the Natural Science Tripos, Part II. (Physics), in 1922, his course being interrupted by the War. With the rank of lieutenant, R.N.V.R., he carried out research in ballistics and the calculation of high-angle trajectories whilst in the Anti-Aircraft Experimental Section of the Munitions Inventions Department. He was elected to a fellowship of St. John's College in 1922 and became a fellow of Christ's College in 1928.

Calendar of Patent Records.

March 17, 1693.—During the seventeenth century there was a large number of patents granted in connexion with apparatus for working under water. One such was granted to John Stapleton on Mar. 17, 1693, for "a new engine soe by him contrived as to permitt a person inclosed in it to walk under water, and of a new invented way to force air into any depth of water to supply the person in the said engine therewith and for continuing a lamp burning under water; also a way to deserate and purifye the air so as to make the same serviceable for respiration." No further details of the apparatus are given.

March 17, 1768.—The art of making porcelain from native materials was unknown in England until William Cookworthy, chemist, of Bristol, discovered deposits of the requisite materials, kaolin and petuntse, in Cornwall and Devon. Cookworthy was granted a patent for the manufacture on Mar. 17, 1768, and established a factory at Plymouth, where the first china made of native clay was produced. The patent was afterwards acquired by Richard Champion of Bristol, and was extended by Parliament.

March 18, 1780.—On Mar. 18, 1780, there was granted to Louis Recordon, watchmaker, of London, the first patent for a self-winding watch. The rewinding was effected by a heavily weighted but lightly balanced lever which was connected to the mainspring spindle and was given sufficient motion to wind the spring by the ordinary movements of the wearer. Breguet, the famous French watchmaker, made several watches with a similar device, and those that exist to-day are said still to work satisfactorily.

March 18, 1862.—To Thomas Dunn, of Manchester, belongs the honour of having filed the largest patent specification. This was lodged in connexion with his patent dated Mar. 18, 1862, for "Improvements in the construction of bridges, roofs, houses, and other structures," and comprises 36 pages of description and 104 sheets of drawings. It was printed at a total cost of more than £650, and formed a volume about 8 in. thick which sold at the price of £2, 13*s*. a copy. The specification is very comprehensive, and includes the construction of bridges, reading rooms, floating fortifications, suspension roofs for railway stations, portable sheet-metal buildings, churches, etc. One of the most interesting proposals is the construction of elevated lattice-work footbridges with spiral staircases which were especially designed to enable pedestrians to cross the busy streets of London, several examples of which are illustrated in the drawings. Dunn was a prolific inventor, twenty-three patents standing to his name in the printed indexes for improvements in machinery of all kinds.

March 20, 1787.—The practical application of machinery to the shearing of cloth, a necessary process preparatory to printing, is due to the Rev. John Harmar, whose first patent for a cropping machine is dated Mar. 20, 1787. In spite of a great deal of opposition the invention was extensively adopted, especially in the west of England, and was in use for many years.

March 23, 1869.—The synthesis of alizarin, the colouring matter of the root of the madder plant and the first of the natural dye-stuffs to be produced artificially, was the work of Carl Liebermann and Carl Graebe of Berlin, who were granted a Prussian patent for five years for their invention on Mar. 23, 1869. Commercial production of the synthetic alizarin was commenced the following year by the Badische Anilin- und Sodafabrik by a process the English patent for which anticipated by one day an application from W. H. Perkin for an identical process.

Societies and Academies.

London.

Royal Society, Mar. 7.—**T. M. Lowry** and **A. G. Nasini**: The molecular dimensions of organic compounds. Part 1: General considerations. A comparative study of the physical properties of benzene with thiophen, toluene with α-methylthiophen, benzene with cyclohexane, all pairs with similar boiling and freezing points, shows that the vapours exhibit regular increments rather than identity of properties; and the physical properties of the liquids and solids, depending on force-fields of molecules as well as on dimensions, show still wider differences.—**A. G. Nasini**: The molecular dimensions of organic compounds. Part 2. An apparatus, based on Rankine's method, has been constructed for measuring the viscosity of vapours, and Sutherland's constant and the mean collision area deduced for benzene and cyclohexane.—Part 3. A further modification of the apparatus is described, in which a zero pressure is used on the condensation side of the capillary. The viscosities of thiophen, methylthiophen and pyridine have been determined.—**W. A. Bone** and **R. P. Frazer**: A photographic investigation of flame movements in carbonic oxide-oxygen explosions. A theoretical $2CO + O_2$ mixture is exploded at atmospheric pressure under varying conditions, such as 'dryness,' 'source and intensity of ignition,' as well as under the influence of superimposed 'shock waves' up to and including detonation. The new Fraser high-speed photographic machine was used. Progressive drying reduces flame velocity and hinders combustion, but the hindering effect can be overcome by a strong electric field. With superimposed 'shock waves' the speed at which a flame starts may be raised in successive abrupt steps until it attains a speed approaching that of the 'shock waves themselves.'—**H. S. Patterson**, **R. Whytlaw-Gray**, and **W. Cawood**: (1) Some observations on the condensation of water on smoke particles. Particles of non-hygroscopic smokes readily absorb water, thus increasing in size, if a small quantity of hydrogen chloride is present.—(2) The process of coagulation in smokes. Experimental graphs, especially for systems of low concentration, show distinct curvature in the direction indicated by theory. Smokes which are most nearly homogeneous give coagulation graphs closely in agreement with Smoluchowski's theory as modified for aerial systems. The smokes studied are formed by molecular collision rather than by condensation around pre-existing nuclei.—(3) The electrified particles in smokes. A method has been worked out for counting directly charged and uncharged particles. The particles of low temperature volatilisation smokes are initially almost entirely uncharged particles, but the proportion of charged particles rises rapidly. Arc smokes and magnesium oxide smokes are highly charged from the start.—(4) The structure of complex smoke particles. Arc smokes often consist of aggregates of great complexity, composed of minute particles, while smokes produced by volatilisation at lower temperature have much simpler structure.—**J. G. Semple**: Cremona transformations of space of four dimensions by means of quadrics and the reverse transformations.—**S. Goldstein**: On the vortex theory of screw propellers. When the distribution of circulation along the blades of a screw propeller is such that, for a given thrust, the energy lost in the slipstream is a minimum, then the flow far behind the propeller is the same as if the screw-surface formed by the trailing vortices was rigid and moved backwards along its axis with a constant velocity.—**O. W. Richardson** and **P. M. Davidson**: The spectrum of H_2: the

bands analogous to the parhelium line spectrum. Part 2. The data give a spectroscopic ionisation potential of H_2 is 15·380 volts. This compares with Pauli's value 23·7 volts on the old quantum mechanics and with $15 \cdot 26 \pm 0 \cdot 13$ estimated from Burrau's computations on the wave mechanics using Witmen's value of the heat of dissociation of H_2.—**R. C. Johnson** and **R. K. Asundi**: A new band system of carbon monoxide. Details are given of a new system corresponding to the transition $3'S \rightarrow 2'P$.—**I. Waller** and **D. R. Hartree**: On the intensity of total scattering of X-rays. General results due to Waller for radiation scattered by a many-electron atom (neglecting 'relativity effects') are used to give an approximate formula for intensity of total (coherent and incoherent) scattering of X-rays.—**C. M. White**: Stream-line flow through curved pipes. A mathematical discussion indicating that for large disturbances, flow in curved pipes is more stable than flow in straight pipes, which is in opposition to the opinion that curvature tends to instability.—**H. A. Wilson**: The theory of cracking petroleum. Calculations are based on theory of chemical equilibrium in mixtures of hydrocarbons discussed in previous papers. When liquid fraction is greater than 50 per cent. calculated gasoline fraction is nearly independent of temperature and pressure, but depends on composition of oil. When all oil is just vaporised the gasoline fraction is nearly the same in all cases. Amount of oil cracked per day in a given reaction chamber at given temperature and pressure is inversely as gasoline fraction.—**A. Fowler**: The arc spectrum of silicon. By passing an arc in nitrogen at atmospheric pressure, and using a vacuum spectrograph, the arc spectrum of silicon has been photographed to about λ1600. Comparison with singly ionised phosphorus, P II, shows the general similarity expected.—**S. F. Grace**: Internal friction in certain tidal currents.—**T. L. Ibbs** and **A. A. Hirst**: The thermal conductivity of gas mixtures.—**D. M. Newitt**, **B. J. Byrne**, and **H. W. Strong**: Equilibrium in the system methyl alcohol—hydrogen—carbonic oxide.—**W. A. Bone**, **F. R. Weston**, and **D. A. Winter**: Further experiments on the combustion of well-dried carbon monoxide and oxygen mixtures. Part 3.—**E. K. Rideal** and **O. H. Wansbrough-Jones**: An investigation on the combustion of platinum. **R. W. Ditchburn** and **F. L. Arnot**: The ionisation of potassium vapour.—**H. J. Gough** and **H. L. Cox**: The behaviour of a single crystal of zinc subjected to alternating torsional stresses.—**F. C. Lea**: The penetration of hydrogen into metal cathodes and its effect upon the tensile properties of the metals and resistance to repeated stresses.—**W. T. Astbury**: A new integrating photometer for X-ray crystal reflections, etc.—**T. H. Havelock**: The dispersion of double refraction in quartz.—**W. L. Bragg**: The determination of parameters in crystal structures by means of Fourier series.—**W. G. Bickley**: Two-dimensional potential problems concerning a single closed boundary.—**P. M. S. Blackett**: On the design and use of a double camera for photographing artificial disintegration.

Linnean Society, Feb. 14.—**E. E. Edwards**: On the morphology of the larva of *Dorcus parallelopipedus* L. Apart from other characters, the larva of *Dorcus* can be separated from those of other European genera of Lucanidæ by the form and arrangement of the tubercles composing the coxæ and trochanteric stridulatory areas. In its internal anatomy it exhibits affinities with certain genera of Scarabæidæ. The nervous system is of an exceptionally primitive character as in *Lucanus*, and does not exhibit the great concentration of the ganglia of the ventral nerve-cord prevalent in larvæ of the allied family Scarabæidæ.—**A. G. Lowndes**: Variation in Arctic freshwater Entomostraca. Many species of freshwater Entomostraca are cosmopolitan in their distribution, and there appears to be no correlation between the difference in environments with variation shown by the separate species.—**S. R. Bose**: The biology of wood-rotting fungi. Viala's culture medium and sterilised wood blocks from which the air had been driven were used. Sporophore formation occurred only in those cultures exposed to light, and was usually associated with poor vegetative growth. When fruit-bodies were formed, they usually occurred on the upper end of the slant towards the glass surface. This is probably related to moisture conditions and the check of vegetative growth.

CAMBRIDGE.

Philosophical Society, Feb. 11.—**T. M. Lowry**: Configuration of quadrivalent atoms. The evidence which led Werner in 1893 to assign a planar configuration to platinous salts of the type $[2NH_3 . PtCl_2]$ is similar to that advanced by Vernon for tellurium and now disproved by Drew, who assigns to quadrivalent tellurium the same tetrahedral configuration as to sulphur. X-ray analysis, however, has assigned a planar configuration to the anions of the tetragonal crystals of $K_2[PtCl_4]$, $K_2[PtCl_4]$ and $Am_2[PdCl_4]$.—**F. G. Mann**: The stability of complex metallic salts. αβγ-Triaminopropane co-ordinates very firmly around the 6-co-ordination octahedron, and in consequence divalent nickel, zinc, platinum and palladium all give salts containing the bis-triaminopropane-metallic complex $[\{NH_2 . CH_2 . CH(NH_2) . CH_2 . NH_2\}_2M]''$. Each metal has adopted the unusual (and in the case of divalent platinum, and palladium, quite abnormal) co-ordination number of 6 in order to provide the octahedron necessary for maximum stability of the completed complex salt. This accounts for their unexpected stability.—**F. H. Constable**: An apparatus for the study of gas reactions on electrically heated films of known area. Electrodeposition on a graphite foundation, from a moving electrolyte, is used to produce metallic films. The area is found by the interference method. Carbon films are produced on graphite by the thermal decomposition of hydrocarbons. While the area of a particular carbon film by the methylene blue adsorption method appears to be 6·8 times the plane area, the area from sections drawn to scale showing irregularities greater than 5×10^{-4} cm. is of the order of twice the apparent area.—**C. P. Snow**: The structure of the nitric oxide molecule. The vibration and rotation spectrum of nitric oxide has been studied upon a large infra-red spectrometer specially designed for the analysis of bands into fine structure. There is found to be one vibration band.

PARIS.

Academy of Sciences, Feb. 4.—**Georges Claude**: The utilisation of the thermal energy of the sea. The experimental plant successfully operated last year at Ougrée is to be transferred to Cuba. It is arranged to work on the difference of temperature between the temperature of the water at sea-level and that at a depth of about 600 metres. The tube will be two metres in diameter and two kilometres in length.—**T. A. Janczewski**: Theorems of oscillation for differential systems of the fourth order.—**R. Wavre**: The problem of the figures of equilibrium of a fluid heterogeneous mass.—**Joseph Pérès**: The actions of a viscous fluid on an obstacle. The case of the ellipsoid.—**P. Noaillon**: Sketch of a new theory of the resistance of fluids.—**Henri Malet**: The propagation of light in the ether.—**L. Mallet**: The ultraviolet radiation of substances submitted to the gamma rays. When pure liquids, such as water, are submitted

to the gamma high frequency radiation, light is emitted. The continuous spectrum of this light appears to be limited by the natural absorption of the excited liquid.—**Pierre Auger**: The influence of the level of origin of the photoelectrons on the distribution in space of their initial directions.—**A. Boutaric**: Remarks on the formulæ representing adsorption isotherms. A comparison of the formula of Freundlich and that of Jean Perrin.—**Pierre Jolibois** and **Louis Chassevent**: The reactions between colloidal silica and lime. The reactions between silica and lime in solution are due to three phenomena, the coagulation of the silica by the lime, the combination of the lime and silica giving a hydrated calcium silicate, followed by adsorption of the lime. In solutions rich in lime this adsorption continues for months.—**R. Bureau**: The experimental study of the zones of silence in the propagation of short [wireless] waves. As a provisional explanation, which further data may cause to be modified, it is suggested that the ionised layers of the upper atmosphere play the principal part but in certain critical cases a very slight modification may decide between two different paths through the ionised layers.—**M. and Mme. A. Chauchard**: The influence of ischemia on the excitability of the cerebral cortex.—**Maurice Fontaine**: The increase in the consumption of oxygen by marine animals under the influence of high pressures. Its variations as a function of intensity of compression.—**Raymond-Hamet**: The glucosides of *Digitalis purpurea*. After a summary of the results obtained by various workers on the toxicity of commercial preparations from digitalis, an account is given of the direct comparison of the toxicity of crystallised digitaline (Nativelle) and pure digitoxine (Clœtta). From experiments on 120 dogs, the physiological activity of these two products was found to be identical.—**Maurice Piettre**: Some properties of serum-albumen: its crystallisation in the absence of any ionogenic element. The application of the acetone method, which permits the analytical separation of the proteins and their preparation in the pure state, has solved the problem of the crystallisation of albumen, without any ionogenic element being present.—**Marage**: The choice of an ear-trumpet.—**Georges Blanc, J. Caminopetros, J. Dumas, and A. Saenz**: Experimental researches on the sensibility of the lower apes to the virus of dengue. Various species were inoculated with the blood of men suffering from dengue. None of the animals showed any clinical signs of the disease and there was no rise of temperature, but their blood, which was non-virulent twenty-four hours after inoculation, became virulent between the fifth and eighth days. The apes thus treated were immune for at least fifty days.

Copenhagen.

Royal Danish Academy of Science and Letters, Oct. 10.—**Niels Bohr**: Quantum theory and relativity. An examination of the difficulties brought to light by the attempts at reconciliation of the quantum postulate with the idea of relativity seems to require a further revision of our fundamental physical concepts as regards their application to atomic phenomena.

Nov. 2.—**Ejnar Hertzsprung**: Proper motions of faint stars in the Pleiades. Provisional results of an investigation in progress. Comparison of old and new plates of the Pleiades taken at different observatories mainly in order to pick out the faint physical members of the group by aid of their common proper motion.—**August Krogh**: The biological assay of insulin. After mentioning the degree of purity attainable in insulin preparations which is ascertainable by chemical assay, a comparison is given of biological methods.

Nov. 16.—**J. N. Brønsted**: The kinetics of ethylene oxides. The apparent basicity of ethylene oxides is explained on the basis of kinetic measurements in aqueous solutions of various composition. It has been possible by these measurements to verify the conclusions of recent theories on reaction velocity. The results obtained have also some bearing upon the general problem of the nature of acids and bases.

Rome.

Royal National Academy of the Lincei, Nov. 18.—**Gino Fano**: Birational contact transformations of the plane.—**U. Cisotti**: Concerning two recent notes by M. Pascal and C. Ferrari.—**U. Cisotti**: Hydrodynamic actions in the proximity of salients.—**A. L. Herrera**: Investigations on the imitation of organised forms with albumen and mineral acids (2). Further structures resembling those of unicellar organisms or of cellular tissues are described. The forms obtained exhibit no evolution or motion; they may be stained with hæmotoxylin and preserved in glycerol.—**R. Calapso**: A transformation of the surface *R*.—**R. Caccioppoli**: The expression of the area of a surface by means of a double integral.—**Silvia Martis in Biddau**: Calculation of the logarithm of a matrix of the second order, and its application to the study of groups of one parameter containing a given substitution.—**V. Glivenko**: The probable values of functions.—**E. Cech**: Asymptotic correspondences between two surfaces.—**E. Pistolesi**: Further with regard to the Kutta-Joukowski theorem in the case of the plane strip.—**G. Viola**: Elliptical elements of the system of U Ophiuchi.—**A. Carrelli**: The theory of sensitised fluorescence. A treatment is given of the phenomenon of sensitised fluorescence on the basis of undulatory mechanics, the method followed being that by which Born elaborated the theory of inelastic shock between the electron and the material atom.—**V. Polara**: Gibb's theorem (phase rule) for heterogeneous equilibria.—**G. Bargellini**: 2 : 6-Dichlorophenetidine. The results of earlier experiments indicated that the dichlorophenetidine prepared by Jaeger by passing hydrogen chloride through an alcoholic solution of *p*-nitrosophenol is probably the 3 : 5-, but possibly the 2 : 6- compound. The latter has now been prepared in another way and proves to be different from Jaeger's compound, which is therefore 3 : 5-dichlorophenetidine.—**G. Mezzadroli** and **E. Vareton**: Influence of metallic magnesium on the formation of formaldehyde and sugars by the action of ultra-violet rays on solutions of calcium bicarbonate. The reducing power (towards iodine solution) developed on exposing calcium bicarbonate solutions to ultra-violet rays attains a maximum after 30 minutes if open basins, or after an hour, if closed vessels of transparent quartz are used; the yield of reducing substances is higher in the latter case. The presence of metallic magnesium in the solutions increases the total quantity of reducing substances formed, and induces the formation of sugars capable of reducing Fehling's solution and of giving an osazone.—**G. Spagnol**: Experiments on the fixation of colloids caused by chloroform. If colloidal mercuric sulphide is injected into the auricular vein of a rabbit and a wad of cotton-wool soaked in chloroform is simultaneously applied for 15 seconds to the animal's side, a sharp black stain of the sulphide is found in the subcutaneous connective tissue under the chloroformed spot when the rabbit is killed—after 2 hours or 8 days. Similar fixation of Trypan blue is observed.—**A. Desio**: Presence of the miocene in Sirtica.—**G. Brunelli**: The epoch of reproduction of *Delphinus*.—**M. Tirelli**: Studies on the physiology of insects (nervous system).—**A. Barchiesi**: Histophysiological investigations on the influence of variations of temperature in certain organs of heterotherms.

Official Publications Received.

BRITISH.

Memoirs of the Geological Survey of India. Vol. 53: The Structure and Correlation of the Simla Rocks. By Dr. Guy E. Pilgrim. Pp. vi+140+xix. (Calcutta: Government of India Central Publication Branch.) 4 rupees; 6s. 9d.

Journal of the Indian Institute of Science. Vol. 11A, Part 16: i. α-Isopropylglutaconic Acid, by K. V. Hariharan, K. N. Menon and J. L. Simonsen; ii. Derivatives of Methyl 2:2-Dimethylcyclopentan-3-one-1-Carboxylate, by C. S. Gibson, K. V. Hariharan and J. L. Simonsen. Pp. 207-220. 12 annas. Vol. 11A, Part 17: i Thiophthalic Acids, Part 1, by Gopal Chandra Chakravarti, ii Organic Cyclic Polysulphides, Condensation of Ethylene Mercaptan with Di- and Trichloracetic Acids, by Gopal Chandra Chakravarti and Jogendra Mohan Saha. Pp. 221-230. 8 annas. Vol. 11A, Part 18: Bio-Semidine Inversion in Aromatic Dihydrazo Compounds. By Praphulla Chandra Guha and Hirendra Kumar Banerjee. Pp. 231-239. 8 annas. (Bangalore.)

FOREIGN.

Appendix No. 2 to Annual Report of the Chief of the Bureau of Navigation, 1928: Annual Report of the Naval Observatory for the Fiscal Year 1928. Pp. iii+38. (Washington, D.C.: Government Printing Office.)

Department of the Interior: Bureau of Education. Bulletin, 1928, No. 18: Private and Endowed Schools offering Trade and Industrial Courses. By Maris M. Proffitt. Pp. iii+50. (Washington, D.C.: Government Printing Office.)

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 8, 1926. iii: Vattenståndet vid rikets kuster. Pp. 21. 2.00 kr. Årsbok, 9, 1927. v: Hydrografiska mätningar i Sverige. Pp. 25+4 plates. 5.00 Kr. (Stockholm.)

Memoirs of the College of Science, Kyoto Imperial University. Series A, Vol. 11, No. 6. Pp. 451-551+10. (Kyoto.)

State of Connecticut. State Geological and Natural History Survey Bulletin No. 43: The Life Forms of Connecticut Plants and their Significance in relation to Climate. By Dr. Beulah Ennis. (Public Document No. 47.) Pp. 100+20 plates+v. (Hartford, Conn.)

Diary of Societies.

FRIDAY, MARCH 15.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—Sir John Russell: Some Agricultural Problems in Australia.—F. L. McDougall: The Commonwealth Council of Science and Industry in its Relation to Agriculture.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 4.30.—Thunderstorms and the Maintenance of the Earth's Electric Field. Chairman, Prof. S. Chapman. Discussion to be opened by Prof. E. V. Appleton, and continued by R. A. Watson Watt, Dr. G. C. Simpson, Prof. C. T. R. Wilson, and T. W. Wormell.

BIOCHEMICAL SOCIETY (Annual General Meeting) (in Department of Physiology and Biochemistry, University College), at 4.30.—I. S. MacLean: Further Observations on the Sterols of Yeast.—H. J. Channon and A. C. Chibnall: The Isolation of n-nonacosane and di-n-tetradecyl Ketone from Cabbage Fat.—J. G. Davis and A. T. R. Mattick: The Metabolism of a Pigmenting Anaerobic Bacterium.—G. N. Richardson and R. K. Cannan: Reaction of Azine Compounds with Proteolytic Enzymes.—B. C. Guha and Prof. J. C. Drummond: Observations on the Concentration of Vitamin B_1.—Prof. J. C. Drummond, R. A. Morton, and K. H. Coward: A Critical Examination of the Methods for the Assay of Vitamin A.—C. R. Harington and S. S. Randall: Isolation of 3:5-diiodotyrosine from the Thyroid Gland.

MEDICAL OFFICERS OF SCHOOLS ASSOCIATION (Annual General Meeting) (at Society of Medical Officers of Health, 1 Upper Montague Street), at 5.—Sir Henry Gauvain: The Combined Education of Children Suffering from Physical Defects.

BRITISH INSTITUTE OF RADIOLOGY (Medical Meeting), at 5.—Discussion on Urinary Cases.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Recent Advances in our Knowledge of the Anatomy and Physiology of the Gall-Bladder.

BRITISH PSYCHOLOGICAL SOCIETY (Æsthetics Section) (at Bedford College), at 5.30.—Mrs. Roberts (Susan Miles) and others: Discussion on Inspiration.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (Annual Meeting) (at Liverpool University), at 6.—L. O. Newton: Boiler Feed Water.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—F. C. Johansen: Research in Mechanical Engineering by Small-Scale Apparatus.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Newcastle-upon-Tyne), at 6.—J. H. Gibson: Mechanical and Transmission Losses in Marine Engines, Shafting, and Propellers.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—C. F. J. Morgan: Wave-form Analysis.

ROYAL AERONAUTICAL SOCIETY (at 7 Albemarle Street), at 6.30.—L. T. Brown: The Napier Lion Engine.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at Glasgow), at 6.45.—Annual Meeting.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (Annual General Meeting) (at Cardiff Technical College), at 7.—T. G. Watts: The Co-ordination of Chemical Industry and Chemical Societies.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group) at 7.

SOCIETY OF DYERS AND COLOURISTS (Glasgow Section) (at 7 Gordon Street, Glasgow), at 7.15.—F. Asquith: The Necessity of Application of Fast Colours on Textile Fabrics.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30—T. Grime: Locomotive Rating.

ROYAL SANITARY INSTITUTE (at Town Hall, Torquay), at 8.—G. J. Loveless: The Plumber and Public Health.

ROYAL SOCIETY OF MEDICINE (Obstetrics Section) (jointly with Maternity and Child Welfare Group of the Society of Medical Officers of Health), at 8.—Discussion on The Future of the Maternity Services.—Openers for Section of Obstetrics: Prof. J. M. M. Kerr and E. Holland.—Openers for Society of Medical Officers of Health: Dr. E. Hill and Dr. J. J. Buchan.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Dr. W. S. Whitcombe: Intensive Ionisation.—Dr. A. B. MacLean: The Prone Position as a Routine Method in the X-ray Examination of the Stomach, with a Note on the Question of Retractability of the Stomach.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. V. M. Goldschmidt: The Distribution of the Chemical Elements.

SOCIETY OF DYERS AND COLOURISTS (Manchester Section).—Short Papers.

SATURDAY, MARCH 16.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South Midland District) (at Uxbridge), at 10.30 A.M.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Western District) (at Guildhall, Bath), at 11 A.M.—Annual District Meeting.

BRITISH MYCOLOGICAL SOCIETY (at University College), at 11.—C. R. Metcalfe: Shab Disease of Lavender.—Dr. G. H. Pethybridge: Exhibit of an Unusual Hypertrophy in Potato Tubers due to *Spongospora*.—Miss K. Sampson: Some Observations on *Epichloe typhina* (Pers.) Tul.—R. S. Vasudeva: On the Parasitic Invasion of Apple Fruit by Various Fungi.—W. R. D. Weston: The Relative Resistance of some Wheat Varieties to *Tilletia Caries* (DC.) Tul. (T. Tritici Wint.).

PHYSIOLOGICAL SOCIETY (Annual General Meeting) (at University College), at 3.—M. C. G. Israels and F. W. Lamb: Carbon Dioxide Equilibria between Mixed Venous Blood and Rebreathed Airs.—Dr. J. S. Haldane: Claude Bernard's Conception of the Internal Environment.—A. Hemingway and J. M. Peterson: The Action of Oxytocin and Vasopressin on the Perfused Isolated Kidney.—Prof. R. S. S. McDowall: The Central Chemical Control of the Heart Rate.—A. P. Gorer and M. S. Pembrey: Observations upon the Respiratory Exchange of Hibernating Mammals.—R. E. Havard and P. M. T. Kerridge: A Change in the Hydrogen-ion Concentration of Blood after Shedding.—Ruth Deansley: The Effect of Toxins on the Adrenal Gland.—G. F. Marrian: The Assay of Œstrin.—A. R. Fee and Dr. A. S. Parkes: The Mechanism of Ovulation in the Rabbit.—A. R. Fee: Experimental Water Diuresis.—A. R. Fee and E. Ogden: Physiological Significance of the Renal Portal System.—E. Leyko: The Action of some Heart Tonics.—E. Leyko and J. Mehes: The Action of Ephedrine.—J. P. Bouckaert: Efficiency and Fenn Effect in Tortoise Muscles.—J. P. Bouckaert, F. Cappellen, and J. De Blenite: Value and Significance of the Constants of Muscle Viscosity.—H. Florey, A. Szent-Györgyi, and M. E. Florey: Methods for Testing for the Presence of Adrenal Cortex Hormone.—M. Grace Eggleton and Prof. C. Lovatt Evans: The Formation and Disappearance of Lactic Acid.—Demonstrations:—M. C. G. Israels and F. W. Lamb: A Modified Henderson Automatic Sampler for Alveolar Air.—E. W. H. Ellis: (a) A Water Driven Centrifuge; (b) Variable Speed Gear; (c) Artificial Lung with Bakerlite Plates (Bayliss, Fee and Ogden); (d) A Perfusion Tap; (e) Perfected Roller Pump (Bayliss).—G. E. S. Ward and S. Wright: Human Electrocardiographic Curves During and After Nitrous Oxide Anæsthesia.—Dr. B. A. McSwiney: A Frog's Heart Chamber.—A. R. Fee and Dr. A. S. Parkes: The Effect of Hypophysectomy (by Decerebration) on Ovulation in the Rabbit.—J. P. Bouckaert: Apparatus for Measuring Muscle Viscosity Extension-time Curve.—F. Gairns: Microscopic Demonstration of Nerve Endings.—Prof. A. V. Hill: The Increment, due to Stimulation, in the Resting Anaerobic Heat-Rate of Muscle.—R. J. Lythgoe: (a) Test Types, (b) Apparatus for Study of Visual Acuity. [Mezzanine.]—W. S. Duke Elder, P. M. Duke Elder, and J. Colle: The Optical Registration of the Intra-ocular Pressure.—E. Bozler: The Heat Production of Smooth Muscle.—F. R. Winton: A Thermostat, Constant to One-thousandth of a Degree Centigrade at Body Temperature.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Molecular Motions in Rarefied Gases (II.).

GEOLOGISTS' ASSOCIATION (North-East Lancashire Group) (at Blackburn Technical College), at 7.—J. Ranson: The Evolution of the Craven Highland.

HULL ASSOCIATION OF ENGINEERS (at Technical College, Hull), at 7.15.—G. E. Petty: Aeroplane Design.

MONDAY, MARCH 18.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Rev. A. H. Finn: Conjectural Emendations in the Psalms.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—C. E. Shattock: Demonstration of Specimens illustrating Diseases of the Testis.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—M. Isacco: The Helicogyre.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London), at 6.30.—K. Brinsmead: Locomotive Lubrication.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—C. Turnbull and others: Discussion on Method in Invention.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—E. Y. Robinson: Radio Sets on the Mains.

BRADFORD TEXTILE SOCIETY (at Midland Hotel, Bradford), at 7.30.—W. Bell: Banking and Commerce.

HUDDERSFIELD TEXTILE SOCIETY (at Huddersfield Technical College), at 7.30.—H. Wilkinson: The Practical Routine of Piece Dyeing.

SOCIETY OF CHEMICAL INDUSTRY AND INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Sections) (at 36 York Place, Edinburgh), at 8.—J. A. Reavell: Heat Transmission.

CHEMICAL INDUSTRY CLUB, at 8.—Dr. C. Singer: Hygiene and History.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—O. G. S. Crawford: Air Photographs of the Middle East.

TUESDAY, MARCH 19.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. R. A. Young: A Medical Review of the Surgery of the Chest (Lumleian Lectures) (I.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. S. W. Kemp: Antarctic Whaling Expeditions (II.).

Mineralogical Society, at 5.30.—A. W. Groves and A. E. Mourant: Inclusions in the Apatites of some Igneous Rocks.—L. A. Narayana Iyer: Calc-gneisses and Cordierite-sillimanite-gneisses of Coimbatore, Madras Pres., and of Similar Occurrences in India.—F. A. Bannister: A Relation between the Density and Refractive Index of Silicate Glasses with Application to the Determination of Imitation Gem-stones.

Royal Society of Medicine (General Meeting), at 5.30.

Zoological Society of London, at 5.30.—Dr. C. J. Van der Klaauw: On the Development of the Tympanic Region of the Skull of the Macroscelididæ.—Lilian Russell: The Comparative Morphology of the Elysioid and Æolidioid Types of the Molluscan Nervous System and its Bearing on the Relationships of the Ascoglossan Nudibranchs.—S. Maulik: On the Structure of the Hind Femur of Halticine Beetles.—J. W. Winterbottom: Studies in Sexual Phenomena—Communal Display in Birds.—Capt. C. R. S. Pitman: Notes on the Vertebrate Fauna of Nkosi Island, Lake Victoria, Uganda, Africa.

Institution of Civil Engineers, at 6.

Institution of Electrical Engineers (South Midland Centre) (jointly with East Midland Sub-Centre) (at Loughborough Town Hall), at 6.45. —Ll. B. Atkinson: How Electricity does Things (Faraday Lecture)

Electrical Association for Women (at 15 Savoy Street), at 7.—H. Bourne: Some Elementary Facts concerning Electric Motors.

Institution of Electrical Engineers (North-Western Centre) (at Engineers' Club, Manchester), at 7.—T. N. Riley and T. R. Scott: Electrical Insulating Papers for the Manufacture of Power Cables.—S. G. Brown and P. A. Sporing: The Prevention of Ionisation in Impregnated Paper Dieletrics.

Institution of Heating and Ventilating Engineers (Associate Members' and Graduates' Branch) (at Milton Hall, Manchester), at 7.—A. E. Cubbage: Address.

Illuminating Engineering Society (at 15 Savoy Street), at 7.—W. Maitland: Architectural Lighting.

Royal Photographic Society of Great Britain (Kinematograph Group), at 7.—E. E. Lamb: Demonstration of Bell and Howell Kinematograph Cameras and Projectors.—B. W. Hanchett: A New System of Studio Lighting for Panchromatic Film, with Mercury Vapour Lamps.

Institute of Metals (Birmingham Local Section) (at Engineers' Club, Birmingham), at 7.—Dr N. F. Budgen: Aluminium.

Institute of Metals (North-East Coast Local Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—Annual General Meeting and Exhibition.

Institution of Automobile Engineers (Inventors' Evening) (at 83 Pall Mall), at 7 45.

Manchester Athenæum Textile Society (at Manchester).—H. P. Curtis: Cloth Faults.

WEDNESDAY, March 20.

Institution of Naval Architects (Annual Meeting) (at Royal Society of Arts), at 11.—Admiral of the Fleet Lord Wester Wemyss: Presidential Address.—Sir William J. Berry: H.M. Battleships *Nelson* and *Rodney*.—Lieut.-Col. F. Dondona: Sea Trials of Italian Destroyers.

Institution of Chemical Engineers (Annual Corporate Meeting) (at Grosvenor House, Park Lane), at 12.15.—Sir Alexander Gibb: The Coordination of Engineering Institutions and Societies (Presidential Address).—At 2.15.—Prof B. P. Haigh: Chemical Action in Relation to Fatigue in Metals.

Society of Glass Technology (at Leeds University), at 2.30.

Geological Society of London, at 5.30.—Sir Douglas Mawson: Some South Australian Algal Limestones in Process of Formation.—Dr. A. W. Groves: The Unroofing of the Dartmoor Granite, and an Outline of the Distribution of the Detritus in the Sediments of Southern England.

Institution of Electrical Engineers (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.—R. W. Gregory: Electric Supply to the Rural Districts of England.

Textile Institute (London Section), at 7.—H. Clayton and others: Informal Discussion on Fabric Printing.

Institution of Electrical Engineers (Sheffield Sub-Centre) (in Mappin Hall, Sheffield), at 7.30 —Prof W. Cramp: The Cause and Effect of Oscillation in Electrical and Mechanical Apparatus.

Royal Meteorological Society, at 7.30 —R A. Watson Watt. Weather and Wireless (G. J. Symons Memorial Lecture).

Royal Microscopical Society, at 7.30.—Capt. M. A. Ainslie, C. Beck, J. W. Gordon, Sir Herbert Jackson, Prof. A. W. Porter, and J. Rheinberg: Discussion on paper by Dr. H. Moore on The Mode of Formation of the Image in the Microscope

Royal Society of Arts, at 8.—Prof. A. E. Richardson Modern English Architecture.

Entomological Society of London, at 8

Royal Society of Medicine, at 9.15.—Dr. L. Williams: Napoleon III.

THURSDAY, March 21.

Institution of Naval Architects (Annual Meeting) (at Royal Society of Arts), at 11.—J. Johnson: The Propulsion of Ships by Modern Steam Machinery.—Dr. J. Bruhn: Some Considerations Regarding International Loadline Regulations.—At 3.—Dr G. Kempf: New Results Obtained in Measuring Frictional Resistance.—C. F. A. Fyfe: The Practical Use of the First British-Built Bauer-Wach Exhaust Steam Turbine Installation in the Booth Liner *Boniface*.—At 8 p.m.—Prof. C. E. Inglis: Natural Frequencies and Modes of Vibration in Beams of Non-Uniform Mass and Section.—S A. Hodges: The Behaviour of Stiffened Thin Plating under Water Pressure.

Chemical Society (Annual General Meeting) (at Leeds University), at 4.30.—Prof. J. F. Thorpe: Co-operation in Science and Industry (Presidential Address).

Royal Society of Medicine (Dermatology and Epidemiology Sections), at 4.45.—Special Discussion: Industrial Dermatoses, their Causation, Recognition, Prevention, and Treatment.

Royal College of Physicians of London, at 5.—Dr. R. A. Young: A Medical Review of the Surgery of the Chest (Lumleian Lectures) (II.).

Royal Institution of Great Britain, at 5.15.—Rev. W. H. Draper. Change of Meaning of Words from One Period to Another.

Institution of Mining and Metallurgy (at Geological Society), at 5.30.

Institution of Electrical Engineers, at 6.—Hon Sir Charles A. Parsons and J. Rosen: Direct Generation of Alternating Currents at High Voltages.—J. A. Kuyser: Recent Developments in Turbo-Generators.

Institution of the Rubber Industry (Manchester and District Section) (at St. Mary's Parsonage, Manchester), at 7.—Dr. G. Barr: Ageing of Cotton contained in Rubber Goods.

Institution of Automobile Engineers (Western Centre) (at Technical School, Gloucester), at 7.30.—L. W. Johnson: The Inspection of Metals and their Alloys.

Batley and District Textile Society (at Public Library, Batley), at 7.30.—J. Brooke: Practical Hints on Carding.

Royal Society of Tropical Medicine and Hygiene (Laboratory Meeting) (at Royal Army Medical College), at 8.15.—Demonstrations by Dr. Mary Andrews, Major E. E. Austen, Major H. C. Brown, Dr. W. T. C. Broom, Major S. Elliott, Dr. E. Hindle, Dr. A. C. Stevenson, Col. S. P. James, Col. W. P. MacArthur, Dr. J. C. Ray, Major D. T Richardson, and Dr. V. B. Wigglesworth.

Royal Society of Medicine (Urology, Pathology, and Therapeutics Sections), at 8.30.—Special Discussion: Urinary Antiseptics.

FRIDAY, March 22.

Institution of Naval Architects (Annual Meeting) (at Royal Society of Arts), at 11 —Eng. Rear-Admiral W. Scott-Hill: Powdered Coal for Ships. —A. Spyer: Modern Developments of the Water Tube Boiler for Marine Purposes.—Eng Rear-Admiral A. E. Hyne: Suggested Modifications to Marine Water Tube Boilers.—At 3.—J. Rennie Barnett: Motor Life-Boats of the Royal National Life-Boat Institution.

Textile Institute (Lancashire Section) (at Manchester), at 1.15.—J. W. Cooling: Air Conditioning Apparatus, including Humidifying and De-Humidifying.

Royal Society of Medicine (Disease in Children Section) (Clinical Meeting at Royal Free Hospital), at 4.30

Physical Society (Annual General Meeting) (at Imperial College of Science), at 5 —Dr. W. H. Eccles: Presidential Address.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Demonstration on the Nerve Supply and Movements of the Colon.

Institute of Marine Engineers, at 6.30.—Annual General Meeting.

Institution of Locomotive Engineers (North-Eastern Centre) (at Hotel Metropole, Leeds), at 7.—T. Robson: Experiments on Buffer Springs.

Royal Photographic Society of Great Britain, at 7.—H. Lambert: Warm Tones on Chloro-Bromide Papers.

West of Scotland Iron and Steel Institute (Annual General Meeting) (at Royal Technical College, Glasgow), at 7.—F. G. Martin: Elastic Limit Steel.

Blackburn Textile Society (at Blackburn Technical College), at 7.30.—A. J. Hall: The Dyeing and Finishing of Cotton Piece Goods containing Artificial Silk

Leicester Textile Society (at Victoria Hall, Leicester), at 7.30.—S. Kershaw: Faults in Yarns.

Junior Institution of Engineers (Informal Meeting), at 7.30.—D. A. Collin: Ventilation.

Royal Institution of Great Britain, at 9 —Sir Ernest Rutherford: Penetrating Radiations.

SATURDAY, March 23.

Royal Institution of Great Britain, at 3.—Sir Ernest Rutherford: Molecular Motions in Rarefied Gases (IV.)

PUBLIC LECTURES.

SATURDAY, March 16

Horniman Museum (Forest Hill), at 3.30.—J. E. S. Dallas: Saxon Churches and their Remnants.

MONDAY, March 18.

East Anglian Institute of Agriculture (Chelmsford), at 7.—W. R. Dunlop: The Economy of Labour in Farming.

TUESDAY, March 19.

Bedford College, at 5.15.—Sir Herbert Baker: Modern Tendencies in Architecture.

SATURDAY, March 23.

Horniman Museum (Forest Hill), at 3.30 —M. A. Phillips: Mammals of Britain.

DISCUSSION.

Friday, March 15.

Faraday Society (at Chemical Society), at 2.30 and 4.30 (*continued from March* 14).—Crystal Structure and Chemical Constitution:—

Part II Organic Compounds:—Sir William Bragg: Introduction.—Dr A. Muller: A Hydrocarbon Model.—Dr. H. S. Piper: Limitations in the Method of Identifying Long Chain Compounds by a Measurement of their Spacings.—Mrs. K. Lonsdale: X-ray Evidence on the Structure of the Benzene Nucleus.

Part III. Metals.—Dr. J. D. Bernal: The Problem of the Metallic State.—Prof. A. F. Westgren and G. Phragmén: X-ray Studies on Alloys.

Part IV. General:—Prof. A. Reis: On the Intensity, Sharpness, and Reducibility of the Debye-Schesser Lines.—Prof. H. Mark: The Methods of Determining the Size and Shape of Small Crystals.—Dr. K. Weissenberg: Lattice Determination in Polycrystalline Aggregates.—Dr. W. T. Astbury: An Integrating Photometer for X-ray Crystal Reflections.—Dr. N. H. Kolkmeijer: Allotropy and the Determination of Densities by X-rays.—Prof. P. P. Ewald: Report on Recent Developments of Wave Mechanics and its Bearing on Crystal Structure.

SATURDAY, MARCH 23, 1929.

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Editorial and Publishing Offices:
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The National Museums at South Kensington.

WE dealt last week with the position of the Natural History Mûseum at South Kensington in relation to the Trustees of the British Museum at Bloomsbury, of which it is a branch. There are eventually to be three museums at South Kensington, and it seems to be desirable that these should be under a single authority interested in the advancement of natural knowledge and its utilisation for the good of the nation. The Interim Report of the Royal Commission on National Museums and Galleries leaves open the whole question of the governance of the national collections, both of museums and of public galleries. The internal control of such institutions and their staffs by directors is clearly a desirable arrangement, but their interrelationships, policy, and development are as certainly matters of public concern. The director is responsible to a Minister, where national funds are concerned, but there is usually some body between, either in a governing or in an advisory capacity. The collections include countless gifts and bequests to the nation, and the nation is the trustee for these. Each gift entails annual expenditure, be it book, picture, machine, or animal, and staffs have to be maintained to care for them, and to see that they are available for the study of experts and for the education and intellectual amusements of the public. Catalogues have to be printed, and special exhibitions arranged, and these do not usually pay for themselves. In addition, certain institutions are so clearly connected with industry and commerce, on which the country and empire so closely live, that annual expenditure is requisite for additions and for the study of these.

The Museum of Practical Geology is the central institution concerned with the mineral wealth of Great Britain and with the nature of the land on which we live and build, and off which we have to obtain our water. By its staff it conducts the Geological Survey in the field, and its Museum is open to the public for reference and advice. The practical application of science to engineering, mining, manufacturing of every sort, and to building construction is the charge of the Science Museum, and its exhibits are judiciously designed to help these. The British Museum of Natural History is, on one hand, of great intellectual value, while on the other, it deals with raw animal products both for food and industry. It is a central reference station for economic biologists and is deeply concerned with the insect and other animal pests which

attack plants and animals. It also has its plant department, while the practical institution for plant products is furnished by the Royal Botanic Gardens at Kew.

These institutions have one characteristic in common, namely, that they are connected with one class of mankind whose sole aim is the increase of natural knowledge, and with a second larger class whose business it is to apply that knowledge to the development of the world. In a word, they are scientific, and their directorates and staff belong to a group of men who are accustomed to act together in mixed societies, in particular in the Royal Society, and in universities. The secret of their successful co-operation lies in their common basic training in respect to natural phenomena, this resulting in a peculiarly impersonal mode of examining any problem presented to them. Year by year they become less separable, since most natural phenomena entail knowledge of two or more 'sciences,' and research year by year is shifting to border lines. The relation of these Museums to one another and to the State deserves careful consideration, for it is obvious that they must continue to grow and progress *pari passu* with the evolution of the country and of the Empire. They can no longer be considered as apart from national prosperity, for they are factors directed to assuring that prosperity, and the cost of their upkeep is a trifling premium. Ideally, they must be in contact with the highest minds in their sciences and with the most interested industrialists.

The position of these four foundations is that they report to and are under the financial control of four different Departments of State. The Royal Botanic Gardens, Kew, are included in the parliamentary vote of the Ministry of Agriculture and Fisheries, and there is no 'governing body' other than the Minister. They are not to be regarded as primarily connected with British agriculture and horticulture, for which other institutions specialise, but with the increase of the basal practical knowledge of plant growth. Their staff is largely concerned with economic interests and research that are imperial in character. Indeed, Kew is a central bureau in all such matters for all the dominions. The herbarium is largely built up of the type collections of colonies and is essential for reference in such work. Distinguished and wise directors have succeeded each other for so long that the director is as nearly independent as any Government servant can be. As plant products have to be grown with an understood relationship to their method of treatment or manufacture—the business of the Science Museum—there is a slight overlapping, but this is not altogether a disadvantage. We think, therefore, that Kew may be left independent of the scheme we have in mind for the Natural History, Science, and Geological Museums.

These three museums are to be topographically connected with each other in the same block at South Kensington, since the Geological Museum is to be removed to a site there in close communication with the other two. At present it is under the Department of Scientific and Industrial Research, which also has control of the National Physical Laboratory, as well as of numerous research boards connected with industry. A committee of the Privy Council, representing many State Departments and all political parties, constitutes this Department under the Lord President, and it is assisted by an Advisory Council, the members of which clearly are principally concerned with its activities in fields other than geology. The detailed supervision of the work is in the hands of a competent committee of the Department. The specimens displayed in this Museum are similar to those shown in the Natural History Museum, but they are arranged differently, as indeed is essential. The palæontological workers are experts of the same order, and clearly the freest possible interchange and the closest relationship between these Museums is likely to be to the advantage of both. The mineralogical collection of the Natural History Museum might be developed to illustrate more clearly the study of rocks, while it is surely the function of the Science Museum to elucidate physical geology.

The Science Museum was a most interesting experiment, which after a chequered existence for half a century, seems to be likely to have a brilliant future in respect both to pure science and to industry. It has a close connexion with the products of art, but clearly its fundamental relationship is in respect to the utilisation of the raw products, with which its neighbours are concerned. The Royal Commission is clearly in agreement, since it has suggested a grant for a conference hall for discussions between industry and science, while it is pointed out that a common lecture theatre is an important need. Here the Museum is under the Minister of Education, whose main interest obviously must be elsewhere and whose appointment must have been largely political. There is an Advisory Council of technical and scientific men, it is true, but the members of such *purely advisory* bodies can scarcely be expected to display

that personal responsibility, the sense of which to a large degree ensures impartiality.

The present seems the favourable moment for the consideration of these national museums as an organic whole. We have in being a Royal Commission, the Interim Report of which shows a rare appreciation of the educational and industrial scope of these institutions, together with a fearless handling of the financial problems related to the guardianship of the public purse. We believe that that essential to all governance, cheerful consent of the governed, would be found to exist were the Commission to propose a scheme which would bring the three scientific museums at South Kensington under one system of control. Thus most easily can uniformity in rate of pay and in promotion in relationship to other scientific posts in the country be obtained. The extraordinarily rapid changes in both science and industry necessitate the governance by experts from all sides in the closest relationship to one another, and they must be led to feel their personal responsibility. Such a result can scarcely be brought about by handing these museums to an overworked Government department, controlled necessarily by experts in one direction. The whole country, not one city, pays for these institutions, and their policy and development must be in the direction of national and imperial interests, the concern of many departments.

Our system demands a relationship to one Minister, and, failing the direct interest of the Prime Minister, which it is too much to expect, the connexion is perhaps closest with the Lord President of the Council, who is selected for his wisdom in affairs and for his wide sympathy with every phase of national development. Under this Minister there would have to be the governing body, with access to him, and with full power to report to him, and in practice to settle the policies of the museums so far as funds allow. It would act through committees for each institution, with perhaps a single annual meeting of the whole body. Only advantage can result from the freest discussion of policy between experts in science and industry—and unquestionably the greater and more practical men of science, as the directors of these museums must be, are happy in the discussion and justification of their views and desires for the advancement of knowledge. The success of such an authority depends on the intelligence and disinterestedness of its members, qualities well displayed by the Royal Commission, which can examine many precedents and will, we trust, make specific recommendations.

Greenland under Danish Rule.

Greenland. Published by the Commission for the Direction of the Geological and Geographical Investigations in Greenland. Editors: Prof. M. Vahl, Vice-Admiral G. C. Amdrup, Dr. L. Bobé, Prof. Ad. S. Jensen. Vol. 1: *The Discovery of Greenland, Exploration and Nature of the Country.* Pp. vii + 575. (London: Oxford University Press; Copenhagen: C. A. Reitzel, 1928.) 40*s.* net. 3 vols., 100*s.* net.

HANS EGEDE landed in Greenland in 1721: for three centuries the Norse colonies had been 'lost'; and Egede's landing was therefore the beginning of a new era of Scandinavian overlordship. The missionary himself wrote a description of the country and its native inhabitants, published in Danish in 1741, and translated into English four years later. There have been other general accounts, but the latest and perhaps the best known is Dr. Rink's "Danish Greenland," which appeared in 1877. Early in the following year the Danish Government authorised the formation of a Commission for the Direction of the Geological and Geographical Investigations in Greenland: publications under the title "Meddelelser om Grönland" began in 1879, and there are now no less than seventy volumes of this well-known series. In more recent years, therefore, the position has been that those wishing to obtain first-hand and up-to-date information could only do so by searching through the seventy volumes of the "Meddelelser." The work under review is definitely meant to remove this difficulty. Essentially it is a summary and co-ordination of the fifty years' research contained in the "Meddelelser." It is hoped to complete it in three volumes in 1929: the present deals with the discovery, exploration, and general nature of the country; the second with the past and present population; and the third with the colonisation and history.

Primarily the book is intended for officials and travellers in the country itself. As a work of reference it will be quite indispensable. Apart from this it is exceedingly well written, and abundantly illustrated with photographs and maps; few countries are so fortunate; it is not too much to say that this is a book to be recommended not only to those closely interested in Greenland, but also to those with slighter interests but appreciation of geographical literature well written and well produced. Its nature is general rather than detailed. In this connexion it should be noted that minute details, district by district, were published

in 1921 in Danish, under the title "Grònland i Tohundredaaret for Hans Egedes Landing," two volumes and atlas. The completion first of the Danish work and now of its English complement will thus round off the intention of the Danish Administration, which, by undertaking these two publications, desired to mark in the most suitable way the bicentenary of Danish rule.

The compilers of the present volume are for the most part well-known geographers, geologists, and biologists. To each has been assigned a particular division, either a physiographical account of one of the coasts, or articles on the flora, on the geology, and so on. To some of the latter articles the position of Greenland, as a bridge between Europe and America, gives important significance. For example, Prof. Ostenfeld traces the origin of the different flowering plants, and finds that about one-fifth are European, whilst the remainder (316 species) must be supposed to be of American origin, or for the smaller part to have survived the maximum of the Glacial Period in Greenland. He strongly favours the survival of the hardiest species throughout the maximum glaciation, and as evidence points to the present condition on certain of the nunataks.

In recent years the interest of geologists has been directed to the need of fuller knowledge of the stratigraphy and tectonics of Greenland, and this to English readers will give more than usual interest to the articles by Prof. Bòggild on the geology of the country as a whole and by Dr. Lauge Koch on the physiography of the northern part. In Dr. Koch's article will be found an account of the Caledonian folds of the extreme north-west; from North Greenland these folds are marked as passing into Ellesmere Land, and their ultimate fate is therefore a problem for Canadian geologists. The folding is regarded as the continuation of our own Caledonian chain via Norway and Spitsbergen, a conclusion which most will accept, though it should be noted that, while the North Greenland folds are well authenticated by fossil evidence, such can scarcely be claimed as fully proved as yet in the Spitsbergen (Hecla Hook) portion of the chain. The further problem of the relationship of Koch's Caledonian Chain with the great thickness of disturbed Lower Palæozic rocks in East Greenland, which according to Prof. Bòggild run for nearly 300 miles from Queen Louise's Land to Davy Sound, has yet to be settled. Here also there would appear to be Caledonian folds, and so disposed that their relationship to the Scottish North-west Highlands may be of considerable importance to the geological history of Britain.

It would perhaps be invidious to select special articles without stressing the exceptional value of the book as a whole: one is tempted, however, to refer to Dr. Birket-Smith's most able and interesting account of West Greenland physiography. The article may be cited as typical of the extreme care and judgment shown by all the contributors; rash conclusions and theories are almost entirely absent, and the body of the work is essentially a collection and marshalling into proper order of the data of scientific observation. By itself alone this first volume is evidence of the foresight and wisdom of the Danish Administration in Greenland, and, when complete, the work should constitute a most impressive proof of the disinterestedness of Danish rule during the last two hundred years.

J. M. WORDIE.

Cohesion, Viscosity, and Lubrication.

(1) *Cohesion and related Problems: a General Discussion held by the Faraday Society, November 1927.* Pp. 49-180 + 5 plates. (London: The Faraday Society, 1928.) 10*s.* 6*d.* net.

(2) *Studies in Molecular Force.* By Dr. Herbert Chatley. (Griffin's Scientific Text-Books.) Pp. xi + 118. (London: Charles Griffin and Co., Ltd., 1928.) 7*s.* 6*d.* net.

(3) *The Viscosity of Liquids.* By Emil Hatschek. (International Text-Books of Exact Science.) Pp. xii + 239. (London: G. Bell and Sons, Ltd., 1928.) 15*s.* net.

(4) *The Theory of Film Lubrication.* By R. O. Boswall. Pp. xi + 280. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1928.) 12*s.* 6*d.* net.

NO property of matter is more obvious, or of more continual importance, than cohesional force. These four volumes deal with many aspects of its study, and of the practical application of our knowledge.

(1) The Faraday Society "Discussion" presents fifteen papers, about half of which deal wholly or partially with the question of why matter in bulk breaks under a stress many times less than would be expected, from what is known about the force of attraction between molecules. There is general agreement that one of the causes of this weakness is the ease with which crystal planes can slip along adjacent planes, so that crystalline substances slide apart instead of resisting a direct pull up to the limit of strength of the molecular adhesions.

Whether surface cracks seriously diminish the strength is a question which receives much attention, but although at first sight there seems to be some evidence in favour of this view, it does not seem certain that the effects sometimes attributed to these cracks are not due to slip planes. The plasticity of wet crystals of rocksalt remains an intriguing mystery; two papers on fatigue and hysteresis in metals leave one with a sense of the importance of incipient cracks and localities of slip, as well as of the great complication of the problem.

Lennard-Jones and Miss Dent contribute another valuable paper on the macroscopic properties of crystals with a completely ionised lattice, calculating these from the electrostatic forces between the ions: this type of work will surely become of increasing importance. At present not much can be done except with the fully ionised lattices, where the interatomic forces are the simplest possible, but two short papers (Taylor, Rawlins) foreshadow avenues of future investigation. These papers represent the limit to which we can now go in deducing the properties of matter in bulk from those of individual atoms. Richards gives an abstract of his work on internal pressures, a conception which has the advantage of dealing just as readily with the effects of molecular motion as with the forces between molecules, but the disadvantage of being in all points decidedly remote from molecular theory.

Other papers include a qualitative deduction of the relative strengths of the adhesions round organic molecules, from observations on surface films (Adam); observations on soldered surfaces (Crow), and on a change in dielectric constant on solidification (Errera). The discussion is not, of course, a comprehensive treatise, but deserves close attention, especially by metallurgists and engineers.

(2) Dr. Chatley's little volume contains notes on a variety of subjects, ranging from the internal structure of the atom to surface tension, viscosity, lubrication, etc. It is scarcely thorough or accurate enough for the serious student, and seems unlikely to attract the general reader, on account of the amount of calculation introduced into the text.

(3) Mr. Hatschek deserves very hearty thanks for his excellent and readable survey of viscosity in liquids. The book is a model of what a monograph should be: the historical, mathematical, and experimental portions are thorough; a great mass of experimental results is admirably marshalled so as to show the bearings on other subjects; technical 'viscometers' have their failings succinctly described, and a comparison of their performance with that of instruments really measuring viscosity is given as far as possible. If all writers of scientific books did their work so conscientiously as Mr. Hatschek has here, students of all classes would have a much easier task than now faces them.

(4) Mr. Boswall's treatise deals with the complete, thick film of lubricant used, wherever possible, to separate the moving parts of machinery. It contains a full mathematical treatment of the hydrodynamics of films of lubricant, with very detailed applications to many types of bearings, including journal bearings and the new thrust bearings with tilting sectors: the effects of the motions of the metal parts are fully considered. The chemical properties of lubricants, although important in determining the adhesion of the oil films to the metal surfaces, and hence in making it easy or difficult to maintain a complete film, receive scarcely any attention, but are evidently considered outside the author's province. The book should be very useful to engineers with good mathematical equipment, engaged on the design of bearings.

N. K. Adam.

Non-Euclidean Geometry.

(1) *Vorlesungen über nicht-euklidische Geometrie.* Von Felix Klein. Für den Druck neu bearbeitet von W. Rosemann. (Die Grundlehren der mathematischen Wissenschaften in Einzeldarstellungen mit besonderer Berücksichtigung der Anwendungsgebiete, herausgegeben von R. Courant, Band 26.) Pp. xii + 326. (Berlin: Julius Springer, 1928.) 18 gold marks.

(2) *Leçons sur la géométrie des espaces de Riemann.* Par Prof. E. Cartan. (Cahiers scientifiques, publiés sous la direction de Gaston Julia, Fascicule 2.) Pp. vi + 273. (Paris: Gauthier-Villars et Cie, 1928.) 60 francs.

THE two books under notice together constitute an excellent introduction to non-Euclidean geometry in all its aspects. The lectures of F. Klein now appear in print for the first time under the editorship of W. Rosemann, though a lithographed edition was published so long as thirty-six years ago. The present edition has been considerably changed as the result of prolonged consultation between the present editor and the distinguished author shortly before the death of the latter.

In its present guise, Klein's book is divided into three parts, the first of which constitutes an excellent introduction to projective geometry in three chapters. The first two of these, on fundamental notions of projective geometry and on forms of the second degree, are new; the third, on collineations or projective transformations, was already included in the lithographed edition. The second part deals with projective metric in six chapters, the last three being concerned more particularly with non-Euclidean geometry. These two parts together constitute four-fifths of the book, but there is a short third part in which the relations between non-Euclidean geometry and other branches of mathematics are considered very briefly, with references to Riemannian spaces and to the restricted theory of relativity. The general treatment is elementary, mainly algebraical, with scarcely any reference to differential geometry, and is admirably clear and profusely illustrated by diagrams, designed to assist the appeal to intuition.

(2) The second book, by E. Cartan, the author of a well-known book on integral invariants, is based on lectures delivered during 1925–26 at the University of Paris. It deals with the geometry of Riemannian spaces almost entirely by the methods of tensor analysis and of differential geometry, and in this respect forms a welcome complement to Klein's more elementary book. The treatment is based on the methods of Riemann and Christoffel, though the more recent work of Levi-Cività and others is fully considered.

The first five chapters are to a certain extent introductory, dealing with such topics as vector and tensor analysis, curvilinear co-ordinates in Euclidean geometry, Riemann spaces which are locally Euclidean, Euclidean spaces tangent to and *osculating* Riemann spaces and geodesic curves and surfaces. The results obtained are applied in the sixth chapter to non-Euclidean spaces. The seventh and eighth chapters deal with Riemannian and vectorial curvature, and the last is on normal co-ordinates and their applications.

This book is much more analytical than Klein's, but, considering the difficult nature of the subject matter, it is very clearly written and commendably free from misprints. The two books in their several aspects can be highly recommended to those who wish to become acquainted with recent developments in general geometry and to fit themselves for an intelligent comprehension of the geometrical basis of the general theory of relativity.

Biology for All.

The Science of Life. By H. G. Wells, Julian Huxley and G. P. Wells. To be completed in about 30 fortnightly Parts. Part 1. Pp. 32. (London: The Amalgamated Press, Ltd., 1929.) 1*s*. 3*d*. each Part.

A NEW educational venture of great attractiveness is "The Science of Life," an exposition of biology, by Mr. H. G. Wells, Prof. Julian Huxley, and Mr. G. P. Wells, a young physiologist, son of the senior author. The work aims at doing for biological science what Mr. H. G. Wells did for history in his famous "Outline," giving to the unlearned a vivid presentation of the essential data. It is to try to be "clear, complete, and correct"; and if the triumvirate cannot do this, who can? There is wisdom in having three authors (tres faciunt collegium); for there is always the possibility of a majority when opinions differ.

We cannot read Part 1 of this serial without envying those who are coming to biology in these days; for the presentation is so picturesque and gripping. Academic formalities have been thrown off without jettisoning accuracy, and everything is discussed in its bearing on everyday life. The increased availability of science promises well for the future, for it is one of the most hopeful lines of human progress that we should become more and more able to utilise our heritage of well-established knowledge.

If we were asked what every young student should know when beginning his voyage of life after schooldays, we should answer—(1) the most significant steps in the history of the human race; (2) how to find his way about in the world of Nature; and (3) the laws of health and happiness. We are not thinking at present of brain-stretching disciplines like mathematics, or of character-forming influences like poesy, but of sheer knowledge. We can see that this "Science of Life" is going to help powerfully towards an understanding of animate Nature on one hand, and towards an understanding of the conditions of health and happiness on the other. We wish it the success it deserves.

The present part begins with the nature of life, a difficult problem to start with. But it is treated very concretely and with an interesting historical background. In any event the reader feels that if this is biology, he wishes some more. Then the story turns to the everyday life of the body—in mouse and in man; and when this can be made vividly interesting, as here, we cannot have too much of it. It is tragic to think of the vast

number of young people who leave school without any understanding of their bodily functions. Such ignorance may have been bliss, though we doubt it, long ago, when all the ways of living were more natural, but to-day it often means disaster. We do not wish to suggest that the new book is particularly designed for young people—though they will welcome it—for it appeals to all who wish more science for more life. In spite of all the expositors, it has to be confessed that a large proportion of the population remain in the Dark Ages as regards the working of their bodies.

There are very effective and interesting illustrations, and the frontispiece shows a crowd of skeletons receding into the distance before the light of microscopy and biochemistry. This we take to mean that necrology will be recessive and biology dominant throughout this book. We trust that this will be so, but it has been our sad experience that the skeleton shows great persistence in its efforts to sneak back to the feast. But all success to the triumvirate!

Our Bookshelf.

British Chemicals, their Manufacturers and Uses: being the Official Directory of the Association of British Chemical Manufacturers (Incorporated); containing a Full List of Members, with a Classified List of British Chemicals and a Note of their Applications. Pp. 330. (London: Ernest Benn, Ltd., 1929.) 10*s.* 6*d.* net.

Salesmanship, so far as it is regarded as a scientific art—one had almost been betrayed into writing 'artful science'—has of late been the subject of some discussion and doubtless of some new resolves. To judge by the general agreement with which certain observations recently made by H.R.H. the Prince of Wales have been received, salesmanship in the modern sense of the term is not one of the strong points of British commercial organisation, at least so far as markets overseas are concerned. All the more credit and publicity should be given to the foresight of those manufacturers who have gone some way towards anticipating at least one criticism—that deploring the lack of adequate presentation to possible purchasers of information in their own languages. Replacing the 1927 issue, a new edition of "British Chemicals, their Manufacturers and Uses," the official directory of the Association of British Chemical Manufacturers, Incorporated, has now been published. The new volume, fully revised, is modelled on the lines of the last edition, and it is intended to bring the book up-to-date every second year. The Association is not itself a trading concern, but exists to promote and facilitate business relations between manufacturing and chemical firms and purchasers all over the world, and to encourage legitimate international trade conditions.

The directory—a sturdily bound volume—is printed (in part sectionally, in part collaterally) in English, French, Spanish, Italian, Portuguese, and German; even the title-page and introductory information appear in sextuplicate. A directory of members of the "A.B.C.M." and of affiliated associations is followed by a classified list of products, their uses, and the names of British manufacturers. There is also a list of proprietary and trade names, the corresponding chemical synonyms or descriptions, and again the names of manufacturers. There is, for example, no longer any need for perplexity regarding the nature or origin of abralac, acrosyl, adalin, or even of westrosol, yarnite, or zinc formosul. Since the list of products is arranged in the alphabetical order of the English names, supplementary indexes in the other languages are provided. The reviewer understands that although the volume is offered for public sale by the publishers, Messrs. Ernest Benn, Ltd., the Association, the address of which is 166 Piccadilly, London, W.1, will nevertheless send a complimentary copy to any applicant who is actually concerned with work in pure or applied chemistry. A. A. E.

The Origins and the Growth of Chemical Science. By J. E. Marsh. Pp. x + 161 + 10 plates. (London: John Murray, 1929.) 5*s.* net.

Mr. Marsh endeavours to show that chemistry has advanced, not through haphazard experiments and discoveries, but by a gradual development of accepted knowledge with the application of logical reasoning to explain established facts. Thus, when Boyle found that mercury calx was re-converted into the metal by heating alone, he was unable to explain the fact. When the phenomenon was rediscovered a century later, science was ready for it. Joseph Black had observed the fixation of a gas in carbonates and the genius of Lavoisier enabled him to establish and explain the fixation of another gas in calxes.

In tracing the growth of chemical science, the author has discarded the practice initiated by Kopp of dividing the development into epochs, since he considers this allows the dominant views of the time to obscure many important tendencies. He instances the phlogiston epoch, which Kopp dates from 1650 to 1775. The discoveries of Boyle and Black are thus made to fall within the same period, yet Boyle never heard of the theory, which was only promulgated in 1702 and, moreover, did not come into prominence until Lavoisier began to attack it in 1775.

The book opens with an account of the early views on the phenomena associated with fire, a study of which led to many important observations. This section, and those dealing with alchemy, the fixation of gases, and some of the later ones cursorily tracing the theories of structure, are well written. In dealing with the philosopher's stone, Mr. Marsh has, however, accepted the doubtful view that Talbot and Kelley are the same person.

The section devoted to the discovery of the elements, which follows an account of Mendeléeff's periodic law and other generalisations under the title "Atoms and Ions," is perhaps not so useful as it might have been. Here the references to the literature are quoted in a confusing manner. Frequently the year, volume, or page (sometimes two) are omitted, and German titles are occasionally misspelt (*e.g.* Poggendorff's *Annalen der Physik*), and the reference (p. 144) for 'the octet theory of valency' (Abegg. *Zelt. An. Org. Chem.*, **39**, 330) will irritate those who desire to consult the original.

In spite of this minor defect, the book presents a useful survey of the origins and development of chemical science. J. G. F. Druce.

Introduction à l'étude de la physique théorique. Par Prof. René Fortrat. Fascicule 6: *Mécanique statistique.* Pp. ii + 100. (Paris: J. Hermann, 1927.) 10 francs.

It is always rather difficult to estimate the value of one detached section of a larger work, for the scale and plan of the whole work can only be guessed. This difficulty is particularly noticeable in attempting to review on its own merits this section of Prof. Fortrat's work entitled "Statistical Mechanics."

To write a successful fairly elementary account of statistical mechanics in a hundred small pages is a task requiring great delicacy of judgment in selecting material. On such questions of taste one need not ask for complete agreement, but the reviewer is forced to admit that he finds the author's judgment poor. In the first place, the last forty pages of the book are devoted to two chapters on the older quantum theory of the atom, too slight to be of much value in themselves and entirely irrelevant to the professed subject matter. They contain, incidentally, statements about the discrepancy between the magnetons of Bohr and of Weiss which might lead an unwary reader to suppose, contrary to the facts, that there is a real difficulty and that the Weiss magnetism is still of some theoretical importance.

The remaining relevant sixty pages are rather good and rather unusual. The subject is treated from the conventional probability point of view, but the ideas and computations of the theory of probability are presented in detail and well illustrated in a way which owes much to Langevin. The applications of the theory have the pleasing and unusual feature of being mainly to magnetic phenomena. There are good short accounts of Langevin's theory of paramagnetism and Weiss's theory of ferromagnetism. If the rest of the book were of the same standard, it could be warmly praised. R. H. F.

The Mechanics of Rowing. By W. B. Coventry. Pp. viii + 70. (London: E. and F. N. Spon, Ltd.; New York: Spon and Chamberlain, 1928.) 4*s.* 6*d.* net.

This is an interesting addition to the literature of rowing, and the work is soundly based on Newtonian mechanics. The terms used are carefully explained, as is also the fundamental problem of connecting the equation of motion of the blade of the oar with the equation of motion of the boat. The variable nature of the effective propelling force is dealt with by the introduction of a constant 'mean effort' operating from the catch to the finish of a stroke.

In the application of the theory to definite examples, it is rightly recognised that, in the last resort, the solution depends on the 'personal equation' of the oarsman. Discussion of such subjects as the length of the stroke, the sliding seat, the weight of the crew and of the coxswain, indicates the practical interest in the racing 'eight' round which the book centres. The effect of the density of the water is dealt with, and perhaps reference might have been made to Thomson's theorem and its application to the hydrodynamical problem of rowing a boat in shallow or deep water. The book concludes with emphasis on stamina and quickness as more valuable assets than big muscles.

H. D. A.

Eutychus: or the Future of the Pulpit. By Winifred Holtby. (To-day and To-morrow Series.) Pp. 142. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., 1928.) 2*s.* 6*d.* net.

Miss Holtby's clever book, which reminds one occasionally of Oscar Wilde, is well worth reading. Students of science are perhaps not much interested in the future of the pulpit, and may agree with Anthony, the young intellectual, that "the pulpit has no future because religion has no future." But the book does, among other things, present an accurate picture of a certain type of vulgar sentimentality which pervades large sections of a modern community. Men of science for the most part are quite unaware of its existence, since their work only brings them into touch with intelligent people. In this dialogue, Eutychus is the exponent of popular religious notions, the devotee of what we may call 'Abide-with-me' religion, with its cinema mentality and vulgar emotionalism. Moreover, Eutychus feels that he holds all the cards. "Whatever the sermon is to be you may be sure that it depends upon just how much I and my friends can stand . . . you've got to pay attention to what we stand for," says he. No wonder that Fénelon, the exponent of Catholic orthodoxy in this dialogue, sums up the situation by saying, "It is the influence of Eutychus which alarms me most." J. C. H.

A First Book of Experimental Science. By W. A. Whitton. (First Books of Science Series.) Revised and enlarged edition. Pp. vii + 194. (London: Macmillan and Co., Ltd., 1928.) 2*s.* 6*d.*

A welcome will be given to this enlarged edition of a school book which has already proved its worth. As to standard, it suits candidates for the junior local examinations; and as to scope, it deals with hydrostatics, mechanics, heat, and a little chemistry.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Equivalent Heights of the Atmospheric Ionised Regions in England and America.

IT was recorded in NATURE of Sept. 3, 1927, that, in experiments carried out for the Radio Research Board of the Department of Scientific and Industrial Research, evidence had been obtained of the existence of at least two ionised regions in the upper atmosphere. This evidence was derived, in the first instance, from observations made at night using wireless waves of medium length as the atmospheric exploring agency, but, more recently, the use of short waves has made it possible to carry out similar experiments during the daylight hours. The results of these experiments confirm the earlier conclusion as to the existence of the two ionised regions while the use of short waves, as was anticipated, markedly lengthens the period during the twenty-four hours when the lower region is penetrable and the upper region accessible. Using a wave-length of just under 100 metres, it is found that even about mid-day the lower region is penetrable on some days. On other days it is found that, due to the inhomogeneity of the lower region, waves of this length are 'reflected' by it one moment and a short time later get through. This is illustrated by a typical series of observations made at King's College, London, on Jan. 13, 1929, using 99·8 metre waves emitted by the National Physical Laboratory transmitter at Teddington, for which the following equivalent heights (km.) of 'reflection' were recorded at 10-minute intervals between 1000 and 1400 G.M.T.: 229, 229, 236, 244, 217, 229, 229, 230, 204, 196, 229, 100, 99, 93, 98, 99, 96, 98, 232, 99 (and 220), 99, 229, 229, 99.

It will be seen that these heights fall into two definite series, of mean values 226 km. and 98 km.

Now measurements of the equivalent height of the ionised layer have also been made in America, and it is of interest to compare the English and American results under similar conditions. For example, Breit, Tuve, and Dahl (*Proc. Inst. Rad. Eng.*, vol. 16, 9, p. 1236; 1928), employing their elegant group-retardation method, have recorded that, at Washington, using 75 metre waves, they obtained evidence of multiple reflections in that effective heights in the ratio 1 : 2 : 4 had been measured. The actual heights recorded were 105 km., 225 km., and 450 km.

Now we may identify the value of 105 km. in America as corresponding to the 98 km. (lower region) in England. But in considering whether the remaining rays are multiply reflected rays from this region or not, we may note that, in terms of such an explanation, the triply reflected ray is missing and that the photographs show that the doubly reflected ray is often of greater intensity than the singly reflected ray. Both of these difficulties disappear if we adopt the double-layer hypothesis for the American results as well as for the English observations. According to this explanation, singly reflected rays were obtained at Washington from regions at heights of 105 km. and 225 km., and a doubly reflected ray was also obtained from the upper region. A close correspondence with the English mean values of 98 km. and 226 km. is thus obtained.

E. V. APPLETON.

Wheatstone Laboratory,
King's College, London,
Mar. 6.

Solutions and Heat Engines.

IT is not usual for an author to complain of a review of his book; but I confess that the theory of osmotic pressure put forward (in place of an account of my own reasoning) by the reviewer, in NATURE of Feb. 16, of my book "Gases and Liquids," almost took my breath away. As the reviewer's reply, in NATURE of Mar. 9, to Prof. Armstrong's criticisms of this theory seems to me totally inadequate, perhaps I may be allowed space for some remarks.

The reviewer says that in a solution "the effect of the bombardment [by solute molecules] is to tend to expand the volume of the solution, and that therefore if water can flow in through a membrane it will do so." This theory implies that a net positive expansion pressure acting from within on the walls of the containing vessel is produced owing to the presence of the solute, and at the same time a net negative pressure causing water to pass in. Any less coherent theory I am unable to conceive. In a solution, no appreciable pressure towards either the outside or inside of the solution exists until the semi-permeable partition is brought into contact on the outside with pure solvent or a solution not isotonic with the solution in the osmometer. There is no pressure because, though the solute molecules exercise pressure, the pressure of the solvent is correspondingly diminished, just as, with gas at constant volume and pressure, there is no change of pressure when we substitute an equal volume of another gas at the same pressure for part of the original gas. The 'osmotic' pressure which develops in an osmometer is quite evidently due to the fact that the more concentrated molecules of the pure solvent diffuse through the semi-permeable membrane faster, until the full osmotic pressure is developed, than the diluted solvent molecules in the solution. It is thus to the solvent, and not to the solute molecules, that the pressure is due, as Prof. Armstrong has pointed out.

In my book I have developed this theory quantitatively, and shown, as I think, that it gives the actual experimental figures for depression of freezing-point, elevation of boiling-point, and osmotic pressure, though not what van 't Hoff wrongly thought were the figures. While I am sorry that the review has given no account of the reasoning in the book, I must not complain; but I think I am justified in joining my protest to that of Prof. Armstrong against what seems to us and many others the incoherent theory put forward by the reviewer.

I have tried in my book to be fair to the memories of van 't Hoff and Carnot, both of whom were men of outstanding genius. But where they were in error they were just in error, like other mortals.

J. S. HALDANE.

DR. HALDANE considers my statement of van 't Hoff's theory (it is not mine) as incoherent. I cannot do better than quote, as an alternative statement, from the account of osmotic pressure in the book under review (p. 109): "Let us imagine pure hydrogen and pure nitrogen at ordinary atmospheric pressure and contained in two equal gas-tight chambers separated from one another by a rigid septum permeable to the hydrogen but completely impermeable to the nitrogen. The hydrogen contained in chamber 1 will immediately begin to diffuse into the nitrogen in chamber 2, and will continue to do so until the pressure of the hydrogen is the same in the two chambers. . . . If the pressure in the first chamber is kept constant, by reducing its volume or letting in hydrogen as required, the pressure in the second chamber will be two atmospheres."

No better illustration than this can be given of osmotic pressure, which in this case is one atmosphere (*i.e.* the difference of pressure between the two sides of a semi-permeable membrane when equilibrium exists). This extra pressure is due entirely to the fact that on both sides there is now hydrogen at one atmosphere pressure, but in No. 2 there is nitrogen as well. Thus there is the extra bombardment inside, and in this simple case (assuming the gases perfect), it is calculable exactly from the expression $pV = nRT$. The nitrogen bombards also the semi-permeable membrane, but this does not prevent the hydrogen from coming in (though with actual molecules, presenting a broad front for attack, it will slow down its *rate* of coming in). It maintains a space extended to receive the hydrogen molecules. If the vessel can stretch, it will do so in consequence of this extra bombardment, and fresh hydrogen will come in to equalise the pressure of the hydrogen once more.

Now, whether we are dealing with gases at low or at high pressures, this kinetic pressure is the same at any given temperature. Perrin's experiments make it certain that it is so even for a condensed gas (*i.e.* a liquid). Serious complications then come in, however, which make exact calculations impossible, but the kinetic pressure is there all the time, and for solutions so dilute that the solute molecules are out of each other's way most of the time, it is found from osmotic measurements to be practically that which a gas would exert if of the same molecular concentration and occupying the same space alone. It is no use, therefore, trying to drag in other causes to explain the existence of osmotic pressure, and in any case it is inexcusable to neglect the kinetic effect.

Dr. Haldane attempts to attribute the *whole* phenomenon to certain volume relations depending upon the replacement of little molecules of solvent by big molecules of solute (thus ignoring the forces which govern the affair); the van 't Hoff school treats these simply as complications, and recognises at the same time that questions depending upon the sizes of molecules and of the attracting forces between them are problems of such extraordinary difficulty that the accurate allowance for their influence has not yet been effected. In dilute solutions their effect is certainly very small.

Dr. Haldane is not at all clear on this part of his subject, and since his whole theory depends upon the precise assumptions made, I thought it best in my review to be content with indicating that the theory was a superfluity, a *vera causa* having already been recognised and successfully developed. Since, however, he evidently desires me to do more, I must mention that on p. 25, where he introduces the volume relations which are the basis of his 'theory,' the results deduced are algebraically wrong. So that, even assuming that the fairly simple gas-law which he takes is good enough, the conclusions that he draws are unfortunately incorrect. I sympathise with him for, also unfortunately, I am personally acquainted by experience with many of the pit-falls which abound.

THE REVIEWER.

Perturbations in the Band Spectrum of Helium.

RECENTLY Kronig put forward a theory of perturbations in band spectra (*Zeit. f. Phys.*, **50**, 347; 1928). He found that if two molecular terms with the same j, which have besides to fulfil certain other conditions, come close together, their mutual influence has the effect that they seem to repel each other. Hitherto no band spectrum has been sufficiently known to permit of testing Kronig's predictions.

In the helium band spectrum a great number of electronic terms is known, and it is therefore especially well suited for a test of the theory of the perturbations. In Fig. 1 the empirical differences between the $4s(j)$ and $4z(j)$ states are represented as a function of j. We see that for $j = 17$ the corresponding energy levels come very close together, and as the two levels fulfil all the requirements of Kronig's theory, we must expect that they will be shifted from their normal positions. Fig. 2 shows how the empirical terms are distributed in the vicinity of the critical point. The dotted lines give the positions which the terms would have if there was no perturbation. The actual term values derived from the analysis of the bands $2p - 4s$ and $2p - 4z$ show just the expected deviations. (The absolute value of the perturbations has been exaggerated in the figure in order to make it better visible.) The exact position of the terms with $j = 19$ and higher is not yet quite sure, as there is a choice of several unclassified lines in that region. It is certain, however, that although the intensity of the preceding lines is large enough, so that we can also expect with appreciable intensity the lines having the terms $4s(17)$ and $4z(17)$, etc., as initial levels, they are not present in the extrapolated positions. Therefore it seems certain that we have indeed here a mutual interaction between the corresponding s and z terms. Similar perturbations seem to exist for the five quantum terms, but as the situation is not so unambiguous as in the case mentioned above, their communication is reserved for a later occasion. In the case of three quantum terms, a similar approach of terms with the same j does not take place, and accordingly perturbations have not been found.

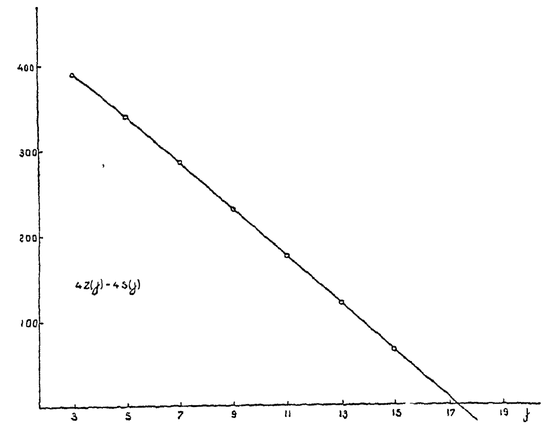

FIG. 1.

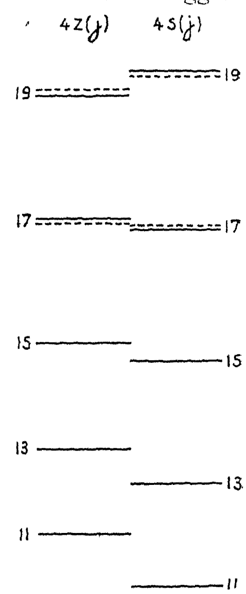

FIG. 2.

The perturbation of the $4p(9)$ term first found by Curtis in the Q-branch of the band $\lambda 367$ mμ, seems to be of a somewhat different nature. A term which might interact with the $4p$ term so as to give perturbations is not yet known. It does not seem impossible that the initial term of the band $\lambda 535$ mμ analysed by Fujioka (*Zeit. f. Phys.*, **51**, p. 657; 1928), which shows a perturbation for the same value of j, is

the term which is responsible for them. The perturbation of the $4p(9)$ term shows a doubling of the corresponding Q-line into two components with unequal intensity. This might be explained in the following way. The spectrum of the helium molecule must consist of single and triple electronic terms. But as the interaction of the electronic spin with the rest of the molecule is very small, the triplets are not resolved and thus have the appearance of single levels. It seems possible that in the case of a perturbation the interaction with the spin gets an abnormally large value, so that the corresponding term is split up. We must imagine, then, that the more intense component of the corresponding line is, as in the case of the atomic lines of helium, an unresolved doublet.

Full particulars of these and other properties of the terms of the helium molecule will be given elsewhere.

G. H. DIEKE.

Natuurkundig Laboratorium der
Rijks-Universiteit,
Groningen.

Cosmic Rays.

IN an earlier communication [NATURE, Feb. 16, p. 241] it was stated that an examination had been made of the results of experiments on cosmic rays. The experiments referred to were those of Millikan and his colleagues. In a recent paper (*Physical Review*, October 1928), Millikan and Cameron divide the rays into four bands with absorption coefficients per metre of water, 0·30, 0·08, 0·04, and 0·02 respectively. There is very little, if any, evidence for the existence of the last band, and I find that their results are fitted just as well by the division of the rays into two bands only, with absorption coefficients 0·30 and 0·051 respectively, rays of type A and type B, say. The experiments of Millikan and Otis and others show that there is a third type of radiation present, type C, say. Rays of this type are of local origin and consist, in part at least, of β-rays with an energy of the order of 100,000,000 electron volts.

Rays of type B are probably γ-rays. If so, according to the Klein–Nishina formula, which, for large values of $\alpha = h\nu/mc^2$ reduces to

$$\sigma/\rho = \frac{4\cdot 17}{\alpha}(1 + 2\log 2\alpha) \quad . \; . \; . \text{ per metre of water.}$$

α for these rays equals 173, corresponding to an energy of 88,000,000 electron volts.

Rays of type C are doubtless γ-rays, with a value of α equal to 1330 and an energy of 675,000,000 electron volts.

The energy presumably released when an oxygen nucleus is formed in a single step from protons and electrons is 116,000,000 electron volts, and that when a proton is destroyed 940,000,000 electron volts. I believe that the formula used gives values of α which are too small, so that rays of type B may correspond to the radiation emitted when an oxygen nucleus is formed in a single step and those of type C to that when a proton is destroyed. Incidentally, it has been tacitly assumed that rays of both types exert no appreciable action on hydrogen and oxygen nuclei. The evidence that rays of either type have any effect on atomic nuclei is not conclusive.

An analysis of the results of experiments showing the variation of intensity of cosmic rays with depth below the surface of the atmosphere affords, then, no evidence of rays corresponding to the formation of helium nuclei from protons and electrons. This renders it difficult to accept the attractive hypothesis of Millikan and Cameron that atom building is taking place in outer space, following the transformation of radiation into protons and electrons. Another difficulty that occurs is this. If all the energy in starlight is so transformed, less than eight-tenths of one per cent of it can be re-radiated as cosmic rays. As the radiation from the sun apparently has no effect on the intensity of the rays, this amount seems too small to account for the large intensity of cosmic rays, estimated by Millikan and Cameron to be about one-tenth that of starlight.

Rays of type C are not easy to classify. Their intensity in air is approximately proportional to that of the rays of type B, although it is difficult to estimate the exact value of either. They are not produced in water or in lead, and are therefore not recoil electrons. Many methods of explaining their origin have been tried, one being that they are photoelectrons ejected from the nuclei of atoms, such as nitrogen, but this explanation is not altogether satisfactory.

We have assumed that rays of type A and C are cosmic in origin, the greater part of the evidence favouring this view, but one experiment carried out by Millikan and Otis indicates that a part at least of these rays may be of terrestrial origin and also that rays of type C may be more penetrating than is usually assumed. They measured the ionisation in an electroscope before and after a snowstorm. When the electroscope was shielded by 4·8 cm. of lead, the ionisation per c.c. per sec. (corrected for natural leak) dropped from 4·9 to 3·6. If this result is not due to experimental error, it would appear that something had occurred in the atmosphere to diminish the intensity of the rays of one or more types.

A more complete discussion of the questions raised above will be given later. In searching for an explanation of the results, equations of the following type have been used, namely:

$$14\cdot 008x + 4\cdot 0022x + \alpha_k = 17\cdot 000x + 1\cdot 0078x + p_k + A_k + h\nu.$$

This is an energy equation representing the ejection of a proton from a nitrogen nucleus by an α-particle, the α-particle being captured by the recoil atom forming an oxygen isotope of mass 17 (the number 17 being assumed). x represents the energy in electron volts radiated when unit mass is destroyed (the mass of an oxygen nucleus being taken as 16 units), α_k, p_k, A_k, and $h\nu$ representing the kinetic energies in electron volts of the α-particle, ejected proton, recoil atom, and assumed radiation respectively.

$$h\nu = 0\cdot 0024x + \alpha_k - p_k - A_k.$$

As $x = 930{,}000{,}000$ electron volts and $p_k + A_k$ is less than α_k, $h\nu$ should be greater than $0\cdot 0024x$, that is, than 2,230,000 electron volts.

It should be possible to detect radiations of this type. Similar equations have been written down for the other atoms from which protons can be ejected, but the results are somewhat indefinite, as we do not know the mass of the recoil atom.

J. A. GRAY.

Queen's University,
Kingston, Ontario,
Feb. 7.

The Ice Age and General Drayson's Theories.

I AM sure your able contributor H. C. P. did not intentionally misrepresent Drayson in his article in NATURE of Dec. 29, p. 1002, but it would seem that some initial unfamiliarity with Drayson's writings, or possibly lack of sympathy with his claims, has led to misapprehension, and I would ask you to be so good as to permit me to direct attention to the more serious mistakes.

(1) "Everywhere in the Draysonian literature nutation is simply ignored."—Nowhere, and at no time, did Drayson ignore nutation; in proof, see "Untrodden Ground in Astronomy and Geology," p. 83; "Motion of the Fixed Stars," p. 23, etc.; though, in common with Sir John Herschel and all other astronomers, when tracing the path of the pole, he had, inevitably, to deal with the *mean* path. The greatest amplitude of nutation, that is, the whole nodding movement across the *mean* path, in direction towards the centre of the circle traced by the pole, is only 18½ seconds of arc. It would need to be 1167 (one thousand one hundred and sixty-seven) times that amount to explain the 6 degrees remove of the precessional centre from the ecliptic pole which Drayson discovered on examination of the records for the previous fourteen hundred years.

(2) "Further than this, the description, such as it is, is devoid of any dynamical basis."—Over and over again, in all his writings, for example in "Untrodden Ground," pp. 256-259, Drayson directed attention to the existing terrestrial conditions that would appear to necessitate a precession different from that assigned to the earth by the mathematicians; a difference he demonstrated by actual experiment with the gyroscope. It is not quite correct, therefore, to say that the movement he described is devoid of any dynamical basis. While it would be out of place to question the calculations of the master mathematicians who have determined the precession dynamically, may it not be reasonable to suggest that the data on which their workings are based are necessarily in the nature of assumptions, difficult, if not impossible, to verify and liable to modification?

May I add that, while it is not necessary to contend for every word that Drayson has written (and he himself was frank to own the limitations of his single-handed research), the need all through has been for simple recognition of the fact that he was offering to science something well worth the trouble of bona-fide examination; and the need to-day is as great as ever for co-operation of friendly team-work, in place of aloofness, to thresh out the question in all its bearings and harvest for science all that is of permanent value.

T. C. SKINNER.

Reigate.

THE moderation of Lieut.-Col. Skinner's letter, in marked contrast to the tone too often adopted by the advocates of Drayson's theory, entitles it to a reply, though without any hope of changing settled convictions. The invitation to join in friendly co-operation under the banners of Laplace, Poisson, and General Drayson is touching and deserves to be appreciated.

Casual mention of a matter like nutation is quite consistent with ignoring it in practice. Col. Skinner denies that it has been ignored, and at the same moment seeks to justify that course on the plea that nutation is very small. But the problem which Drayson approached was that of the motion of the earth about its centre, and in that problem dynamical astronomy has to deal with precession and nutation together. From this point of view the relative magnitude of the latter is irrelevant. As well might one leave out of sight the loops in a row of knitting on the ground that very fine needles were used.

This failure to grasp the integrity of the problem in itself betrays the lack of any dynamical basis in the treatment of it. Col. Skinner refers to mistakes, and has had an opportunity of correcting them. It will be observed that in the one case he has failed to indicate what part, if any, nutation plays in the Draysonian scheme, and in the other he has not suggested in what way, if any, the scheme derived support from dynamical reasoning of any kind. Drayson may have alluded to nutation and toyed with gyroscopes (most people have spun tops in their time), but what remains as obscure as ever is what part these things played in a theory the purely geometrical and empirical character of which is as clear as day.

An attitude of Athanasius *contra mundum* may be impressive, but the majority is not invariably wrong. The work of the master mathematicians, so far from being sacrosanct, has received repeated and critical study. The unfortunate thing is that Drayson and his followers have never shown the slightest inclination to come to close grips with it. When they have undergone this arduous discipline, they will have formed a juster view of the situation. H. C. P.

Compressibility of Crystals and the Exponent of the Force of Repulsion between Atoms.

IT is recognised that a real crystal does not have a perfectly uniform structure, but that it consists of a large number of small perfect crystals with a system of submicroscopic cracks between them. The average size of the perfect unit is, according to A. Smekal (*Zeitschrift fur technische Physik*, p. 535; 1926), about 10,000 molecules. The presence of the submicroscopic cracks is made responsible for the tremendous difference between the experimentally determined values of tensile strength and those computed from theoretical considerations. As is known, the latter are several hundred times larger.

M. Born ("Atomtheorie des festen Zustandes," pp. 734-735) calculates the exponents of the forces of repulsion between the ions in a crystal lattice from the compressibilities of the crystals. In this way he arrives at the well-known value 9, from which certain conclusions of importance are drawn as to the symmetry of electronic arrangements in the ions (resp. atoms). The fundamental implicit assumption of all calculations of such a kind is that the coefficient of compressibility, as determined by the usual methods, is characteristic for the ideal crystalline space lattice.

Are we justified in making this assumption? If the tensile strength of a crystal is reduced several hundred times due to its loose structure, should we not expect that the compressibility, as usually determined, is also a characteristic, not of the ideal perfect crystal, but of the real loose crystal? It is easily seen that if the above-mentioned structure of the real crystal should have any influence at all on its compressibility, the effect should be one of increasing the latter. When subject to compression, the real, loose crystal may decrease in volume solely due to closer packing of the perfect units, that is, due to a decrease of the volume of the system of submicroscopical cracks. The compressibility of the individual crystallites may be very small, even zero, and still the crystal as a whole may show a considerable reduction of volume under pressure.

It is difficult to estimate how large such an effect may be. But the following considerations may give some indications. According to Siedentopf, the width of the submicroscopic cracks is of the order of 10^{-7} cm. (W. Rogowski, *Archiv fur Elektrotechnik*, vol. 18, p. 147; 1927). Assuming the crystallites to be cubical, we find that there are about 21 atoms along the edge of the cube. If, furthermore, we

assume that the width of the crack given above represents the average spacing between the adjacent crystallites, we find that the total volume of the cracks is of the same order of magnitude as the volume actually occupied by the perfect crystallites. This is certainly much too high an estimate. But it now becomes not improbable to assume that the total volume of the cracks equals within a few per cent the volume of crystallites. The compressibilities being of the order of 10^{-6} cm.^{2}/kgm., we see that even at pressures of about 10,000 atmospheres the relative change of volume is only a few per cent. Hence, it is not impossible that practically the whole change of the volume is due to the decrease of the size of the cracks.

Hence we see that the measured compressibilities may be considerably larger than those which would be found if we dealt with a perfect crystal. But this means that the exponents of the forces of repulsion between the ions are considerably higher than 9. If this should be confirmed, it would necessitate also a revision of some of the conclusions drawn from previous data. It is perhaps worth noting that J. E. Jones (*Proc. Roy. Soc.*, A, vol. 106, pp. 441, 463; 1924; and vol. 107, p. 157; 1925) finds for some gases considerably higher exponents from different considerations.

Since the system of cracks in a real crystal is of prime importance also for a great number of other properties, such as conductivity of dielectrics, optical phenomena (Smekal, *l.c.*), and electrical break-down strength (Rogowski, *l.c.*), it may perhaps be possible to investigate this question by the study of the above-mentioned properties under high pressures.

N. RASHEVSKY.
Research Department,
Westinghouse Electric and Manufacturing Co.,
East Pittsburgh, Penn.,
Jan. 16.

The Beta-Hormone.

THE œstrous cycle is but one phase, and the less important phase, of the whole sexual cycle. There are *no* mammals in which the reproductive phase of the cycle (pseudo-pregnancy) does not also occur—either regularly or under given conditions. But there are *some* (the primates) in which no œstrous phase appears, since the whole cycle consists of a pseudo-pregnancy. Pseudo-pregnancy depends upon a hormonic function of the ovary, and is entirely independent of the presence of ova, fertilised or unfertilised, mature or immature (Wiesner, 1927). It becomes necessary, therefore, to decide whether pseudo-pregnancy is caused by the same hormone or hormones as that which invokes the œstrous cycle.

Alpha hormone (œstrin—the cornifying factor) in particular must be tested. But Wiesner has shown that alpha does not produce the typical changes of pseudo-pregnancy. Moreover, an already existing pseudo-pregnancy can be interrupted by injections of alpha.

In an attempt to explain the mechanism of the sexual cycle, the assumption was made that there existed a second ovarian hormone which was required to act in two ways: (*a*) to prevent alpha causing œstrus (in animals where alpha occurs during the second phase—be it pseudo-pregnancy or pregnancy); (*b*) to produce the typical changes of pseudo-pregnancy which cannot be produced by alpha.

Recent work done by Wiesner in 1927–28 and by ourselves aimed at the isolation of this hormone or the factors of which it consists. Now we have found that the corpus luteum contains a substance which can be extracted and causes at least some of the effects ascribed to this hypothetical beta-hormone.

The method of extraction was one of those which were used in the preparation of rho-one (ρ_1)—that particular 'pituitary'-hormone which causes œstrus and ovulation in the diphasic animal (Wiesner and Crew, 1928). The simplest method is that of shaking an aqueous suspension of finely divided substance of corpora lutea (cattle) after addition of sulphosalicylic acid (conc. about 15 per cent). A precipitate forms, and filtration leaves a large part of the beta in the liquid; the evaporation of this extract at 56° and the removal of the sulpho-salicylic acid from the residue by means of alcohol leaves a water soluble substance the injection of which can produce effects required of beta by the working hypothesis. For it prevents the atrophy of the uterus in ovariotomised mature mice, a phenomenon appearing normally in all castrated animals; the muscular layers of the uterus of the experimental animals showed full development. The epithelial cells are increased in number and size; high epithelial activity prevails. The uterus never appears to be dilated by fluid (as it is after injections of alpha). The vaginal epithelium is *not cornified*, but forms *a layer of high mucous cells*—as in pregnancy or pseudo-pregnancy.

The effects caused by this substance, the beta-factor of the ovarian hormone, permits one to conclude that it is one, if not the factor, which is responsible for the second phase of the sexual cycle (pseudo-pregnancy) in diphasic animals and for its equivalent (premenstruum) in monophasic animals.

Further purification of the extracts and a study of the effects of beta is the object of experiments now in progress; the formation of that particular vaginal epithelium which can be recognised in a small excised piece of the vaginal wall and is characteristic for the second phase is used as the test for the presence of this ovarian hormone, which is the second, but most probably not the last one to be extracted and described.

B. P. WIESNER.
JASHBHAI S. PATEL.
Animal Breeding Research Department,
The University, Edinburgh,
Feb. 24.

Practical Television and its Problems.

THOUGH I see that it is largely taken from a foreword written by so high an authority as Sir Ambrose Fleming, I should like to put on record my strong dissent from a sentence in the review of A. Dinsdale's book "Television," in the supplement to NATURE for Mar. 9. The statement that I object to is: "The great obstacles to radio television to great distances at present are the disturbances caused by fading, Morse signals, atmospherics, and all the other causes which mutilate the broadcasting of speech and music."

On the contrary, as a matter of fact, if the difficulties occasioned by all these troubles were entirely eliminated, there would remain two fundamental, and, so far as present methods are concerned, insuperable difficulties against obtaining really successful practical radio television.

The first, which applies to all television, either by radio or by wire over distances either long or short, is, that with present mechanical methods it is only possible to produce transmitting or receiving apparatus with which the pictures can be divided into numbers of units which, for real success, would have to be multiplied at least by hundreds, if not by thousands.

The second difficulty applies only to television by

radio and not by wire, but applies obviously to broadcasting, and consists in the fact that where television is made by radio, such broad bands of frequencies must be used in order to get the necessary details to form really successful images, that these bands must cause unbearable interference with all other wireless systems in the neighbourhood.

I may add that I have received both a letter, dated Mar. 1, and a copy of an article in the *Elektrotechnische Zeitschrift* for Nov. 29 last, from Prof. Arthur Korn, of Charlottenburg, the well-known pioneer in the transmission of pictures by telegraph, that fully bears out these views of mine. He says in his letter, "In reality, I think that all the present trials of television are without great practical value, and only when it will be possible to receive many hundreds of thousands of elements per second practical television will begin."

A. A. CAMPBELL SWINTON.

MR. CAMPBELL SWINTON loses few opportunities of attacking mechanical methods of television. We have seen what we and many experts, including Sir Ambrose Fleming, consider excellent pictures transmitted by mechanical television. It is somewhat late in the day to point out difficulties in the way to experts. As Mr. Campbell Swinton has quoted Prof. Korn, we may be allowed to quote the following extract from a letter dated Feb. 19, by Commandant Brenot, Chief Engineer of Radio Paris, one of General Ferrié's most brilliant pupils: "What Mr. Baird has done is far ahead of what the most optimistic spirits could have dared thinking only a year ago at the International Wireless Conference held in Washington."

Six or seven stations in America are already broadcasting television pictures by various methods with a somewhat limited amount of success. Experimental transmissions on the Baird system will shortly be tried in various continental countries. The matter is being considered at present by the Post Office officials in Great Britain and we are quite content to leave the question of broadcasting television in their hands, as we know that they are competent and quite unbiased.

THE REVIEWER.

Magnetic Storm of Feb. 27-28.

ON Feb. 27–28 occurred one of the greatest magnetic storms recorded at this Observatory in the present solar cycle. The range in declination (100′) has been exceeded once only, on Oct. 15, 1926 (>164′), in the cycle, and that in horizontal force (530 γ) has been exceeded on three occasions only, namely, on July 8, 1928 (>600 γ), Oct. 15, 1926 (>717 γ), and April 14–15, 1926 (585 γ). In both the recent storm and that of last July the minimum of H.F. was beyond the limits of registration, so that it is not possible to give the exact value of the range.

The recent storm was not marked by a 'sudden commencement,' but was preceded by slight and moderate disturbances respectively at about the same hours on the two previous days. The duration of the storm was approximately from 15 h. 30 m. on Feb. 27 to 4 h. on Feb. 28, but the more violent phase was confined to the interval between 18 h. 30 m. on Feb. 27 and 1 h. 30 m. on Feb. 28. The character of the record strongly suggests that the violent phase of the disturbance was due either to a different cause from that responsible for the more moderate disturbances at the beginning and end of the storm, or to a marked discontinuity in the conditions under which a common cause operated. This is especially observable in the declination record, in which all the maxima and minima of the violent phase are sharply pointed, whereas in the initial and final stages they tend to be rounded. Further, the beginning and end of the central phase are very sharply marked, especially the end, which is as abrupt as if it had been brought about by the opening of a switch on an electric circuit.

It is worthy of note that the most violent movement of the storm was centred at about 20 h. on Feb. 27, at which time, according to reports in the Press, telegraphic services were seriously disorganised. Between 21 h. 42m. and 21 h. 57 m. there was a rise of 72′ in declination, followed by a fall of 80′ between 21 h. 57 m. and 22 h. 2 m., whilst between 21 h. 53 m. and 22 h. 8 m. there was a rapid fall and rise in H.F. of over 370 γ, the trace being off the sheet from 21 h. 58 m. to 22 h.

There were a few insignificant groups of spots near the central area of the solar surface, but nothing which would lead one to anticipate any notable magnetic disturbance, nor does the storm appear to be in sequence with any previous ones at about the 27-day interval. It will, however, be interesting to see if it is followed by another at about Mar. 26, and, if weather conditions are favourable, it would be well if observers would be on the look out for aurora at about that date.

J. P. ROWLAND, *S.J.*

Stonyhurst College Observatory,
Nr. Blackburn, England,
Mar. 7.

The Presence of Sulphur in the Gaseous Nebulæ.

MANY of the strongest lines in the spectrum of the gaseous nebulæ have been explained (NATURE, **120**, p. 473; 1927. *Astrophys. J.*, **57**, p. 1; 1928) as forbidden transitions from low metastable states in oxygen and nitrogen. The analysis of the S II spectrum by Ingram (*Phys. Rev.*, **32**, p. 172; 1928), combined with the intercombination lines recently classified by L. and E. Bloch (*C. R.*, **188**, p. 160; 1929), makes possible the prediction of the position of lines due to similar jumps in singly ionised sulphur as follows:

Transition.	λ Calculated.	λ of Nebular Lines.
$a^4S - a^2P_2$	4068·39	4068·62
$a^4S - a^2P_1$	4076·45	4076·22
$a^4S - a^2D_3$	6717·04	—
$a^4S - a^2D_2$	6731·30	6730·0

The last column of the table gives the wave-length of lines found in the nebulæ. The agreement in every case is within the error of the calculated wave-lengths, which depend on frequencies of lines in the extreme ultra-violet. 4068·62 and 6730·0 were listed previously among the unclassified nebular lines (*loc. cit.*), while 4076·22 was provisionally assigned to O II, although its intensity was much stronger than the intensities of other O II lines would lead one to expect, and consequently the identification was indicated as being doubtful. Judging by the behaviour of the homologous lines in O II, 6717 should be weaker than 6731, and consequently its failure to appear is not surprising.

It may be noted that all of the elements thus far found in the nebulæ, namely, hydrogen, helium, carbon, nitrogen, oxygen, and sulphur, are gases or have stable compounds that are gases at low temperatures.

I. S. BOWEN.

Norman Bridge Laboratory,
California Institute,
Pasadena.

British Oyster Fisheries.

By Dr. J. H. ORTON.

THE present depleted state of the British—and indeed also of most European—oyster fisheries, with the resultant scarcity of marketable oysters, is the main cause of the current high price of this delicacy. The high value of the native oyster (*O. edulis*) especially, has attracted attention to the probable values of old and neglected former oyster fisheries, and to the possibility of beginning new fisheries in localities where such have not previously existed. Any attempt at improvement of our inshore fisheries may be welcomed, and particularly when directed towards the culture of sedentary animals, which promise more definite economic returns for effort expended than most other fisheries. A broad view of the problems in oyster-culture should, however, be regarded as a necessary preliminary to all new schemes, for, as Hoek insisted, "Oyster-culture *is* a culture and not a manufacture."

TABLE I.—THE WORLD'S OYSTER PRODUCTION FOR 1912–1926[1] (*according to statistics*).

Country.	Chief Species Cultivated.	Unit of Quantity Stated in	Total Value in Most Recent Year.	Production in 1926.	1925.	1924	1922.	1920.	1918.	1914.	1912.
U.S.A.	*O. virginica*	1000 bushels[2]	$14,000,000	..	..	**20,000**	..	..	..	**30,000**[6]	..
Canada	*O. virginica* *O. lurida*	Barrels each =*c.* 3 imperial bushels	$152,073	22,255	21,428	28,982	19,427	14,526	13,916	26,545	23,377
France	*O. angulata*	Millions	francs 107,463,624[4]	*1083·7*	*889·7*	*660·4*	*439·6*	*378·4*	*546·2*	*692·6*	*1064·5*
France	*O. edulis*	Millions	francs 6,565,580[4]	*10·87*	*7·98*	*29·28*	*208·1*	*463·3*	*414·1*	*739·7*	*944·6*
Holland (Zeeland Rivers)	*O. edulis*	Millions	gulders 1,967,850	*17·07*	*18·23*	*24·85*	*27·54*	*36·37*	*41·65*	*30·35*	*45·13*
Zuider Zee	*O. edulis*	Thousands	..	..	..	nil	13·6	953·0	421·0	8495·0	..
England and Wales	*O. edulis*	Millions	£101,480[5]	*15·86*	*16·74*	*16·97*	*23·67*	*39·44*	..	..	*33·39*
Ireland	*O. edulis*	Thousands	£7,619	1,622	2,065	2,410	151	3,621	2,099	1,866	2,909
Scotland	*O. edulis*	Thousands	£579	83	96	89	144	254	..	705	1,328
New Zealand	*O. Angasi*	Bags, each= *c.* 3 bushels	£19,479	27,828	26,039	23,796	27,280	26,703	22,827	24,793	..
New Zealand	*O. cucullata*	Bags, each= *c.* 3 bushels	£8,344	6,771	8,297	6,841	7,323	6,797	10,422	8,361	7,728
N.S.Wales	*O. Angasi* *O. cucullata*	Bags, each= *c.* 3 bushels	£85,141	..	..	28,380	24,811	25,021	22,337	21,526	..
Natal	*O. cucullata* *O. prismatica?*	Dozens	£762	17,288	22,855	24,876	17,859	21,909	15,172	13,433	19,000
Japan	*O. cucullata* *O. gigas* *O. densilamellosa*	Thousands of kwan,[3] each= 8·267 lb. or 3·75 kgm.	yen 551,039	**3,070**	**1,874**	**2,033**	**3,277**	**10,677**	**9,278**	**330**	..

[1] These statistics are given as stated in the various Government reports in the pre- and post-War periods, but as they relate to overlapping seasons are not all strictly comparable in the same year. The figures for France relate only to the total output by oyster culture, and those for England do not include the output from the Fal Estuary. In each country the statistics are apparently comparable from year to year, and thus afford an index of the varying prosperity of the oyster industry in each region

[2] One bushel may contain any number of American oysters from 200 to 500, according to size.

[3] One kwan=the weight of about 66 medium-large English oysters

[4] Values for 1927 for respectively 1452·3 and 6·39 millions. [5] Value for 9·71 millions in 1927. [6] For the period 1911–1918.

One of the chief difficulties in oyster culture is the fluctuation in the supply of small stock—which is the equivalent of raw material in a manufacturing trade. On many English oyster beds recurrent periods of relative scarcity of small stock occur not infrequently, while at longer intervals great scarcity of all kinds of stock may occur. The cause of these minor and major fluctuations has been in the past undoubtedly mainly the failure of the crops of young oysters for successively few or many seasons. In a good season many millions of young oysters may be obtained, in contrast with a very small fraction of this number in a bad season. One good season in about five would ordinarily be sufficient to maintain a bed in a flourishing condition, provided an adequate breeding stock be always maintained.

The present scarcity of oysters on English oyster beds is due to several causes, of which the failure of good crops of young oysters since 1921 is probably the predominant one. Other factors of importance in this regard are (1) an unusual mortality in the Thames Estuary area in 1920, (2) over-fishing, and (3) the possible occurrence of increased pollution in inshore waters with a resultant lethal effect on larval and young oysters. These matters, along with a consideration of enemies, pests, local effects of unfavourable weather conditions, in addition to the purely economic factors, need to be considered in ventures upon oyster culture.

The condition of British oyster fisheries is, however, intimately related to that existing in Holland and France, since these countries have in the past furnished a source of cheap young oysters for stocking British grounds. In France, depletion of the beds (of *O. edulis*) has occurred contemporaneously with and from causes the same as or similar to those operating on British beds. Conditions in Holland have recently been more favourable, but have resulted here also in fluctuating periods of relative scarcity. Thus at the present time stocks of small oysters are low throughout western Europe. Table I., however, shows that stocks of all kinds of oysters, as judged from statistical returns, are relatively low over

most parts of the world. The true significance of these figures could be better estimated by comparison with a longer series, but nevertheless in themselves indicate the operation of some common factor or factors. Of these factors, frequent failure of the young oyster crops and overfishing are probably the most important, with increasing pollution as a factor of least but possibly increasing importance.

The occurrence of good crops of young oysters on English beds is closely correlated with warm summers, and on natural grounds there is little doubt that heavy falls of oyster-spat are dependent directly or indirectly upon a more or less sustained temperature of the sea-water at 60° to about 64° F. or above. In some seasons a good spatfall may be obtained, but even so, the yield of young oysters in the following spring may be slight; in other seasons, in spite of the demonstration of abundant larvæ in the waters over the beds, there may be little or a negligible spatfall. It is advisable, therefore, to distinguish (*a*) the summer settlement of larvæ, as the spatfall, and (*b*) the product in the following spring, as the young oyster crop. The best crops occur after long warm summers,[1] *e.g.* 1913, 1921, or from an early spatfall. A complete scientific explanation of the factors concerned—which may be biological or purely biophysical—is still awaited, hence the need for prosecuting with vigour the investigations at Conway (referred to in NATURE, **123**, 208) on the factors controlling spatfall and the survival of spat. In the meantime, good crops of young oysters can only be expected on oyster beds either after long warm summers or when a warm period occurs in summer at about the time when a good proportion of the season's larvæ are ready to settle.

Thus although researches on improved methods of spat-catching in the sea[2] may improve the oyster cultivator's probabilities of better crops, he is nevertheless dependent upon suitable weather, which is an unpredictable factor, for maintaining a succession of crops. In this matter the steady production of millions of young oysters in artificial ponds at a cheap rate would immediately extend the possibility of oyster cultivation in Great Britain. The English Fishery Department has already had considerable success in obtaining oyster crops in artificial tanks at Conway,[3] and it is suggested, could now attempt a *commercial* experiment on a grand scale, namely, prepare for and secure a crop of millions of young oysters; then, either sell the crop, or arrange to relay the product on existing oyster beds and cultivate them to a marketable size. In the former case a demand sustained over a period of years would prove success, as would a satisfactory balance sheet in the latter. In either case the Government might prove the value of its scheme empirically, before scientific assurance arrives.

In the unusual mortality of oysters in the Thames Estuary in 1920, it was found impossible[4] to incriminate as the agent, trinitrotoluene, which had previously been dumped in this area in large quantities. Nor was it possible to assign the mortality to any other lethal substance known to have been dumped in the sea in the post-War epoch. Thus the cause of the unusual mortality was necessarily left an open question: it might have been due to unknown poisons, or to unrecognised parasitic disease. The occurrence of heavy mortality in oysters at Taranto, Italy, in 1919, and on French beds, especially at Arcachon in 1920, renders it more likely that some parasitic organism was the common cause, though no suspicious parasitic form has yet been found. As oysters are known to die from constitutional disorders brought on by extreme variations in external physical conditions, a determination of the cause of death in any given case is rarely possible. The physiology of the oyster is thus extremely interesting from an academic as well as from an economic aspect. For this reason—and others—it was strongly recommended[4] (1923) that a post-graduate scholarship should be permanently founded for continuous researches on the physiology and biology of the oyster. Such a scholarship was awarded to Dr. C. M. Yonge for two years—and resulted in a valuable contribution to our knowledge of the physiology and anatomy of the oyster[5]—but has now unfortunately been allowed to lapse. It may be again emphasised that the continuance of researches of this nature will add to our knowledge both of general biology and the special biology of the oyster in relation to culture.

The effects of over-fishing in the falling off of oyster production are, in the opinion of the writer, frequently underrated. On a question of this kind, in which adequate scientific facts are not available, it is necessary to fall back on general principles. One oyster can produce one million larvæ at a time, just as a codfish or a sea-urchin may produce several million eggs, and it is often argued that quite a few individuals in a favourable season would be sufficient to produce a big stock of young. The matter is important generally, and not merely confined to the oyster. It is true that in extremely favourable circumstances a few individuals of one marine animal may produce a large population in the succeeding year or years, hence the view—especially held in oyster culture—that a stock may be reduced (over-fished) to very small dimensions with impunity. Fisheries in America, Australia, Scotland, and the German Bight have probably died out from acceptance of this doctrine. It is, on the other hand, a generally accepted doctrine that the number of eggs produced per individual in a species is directly proportional to the probable rate of mortality before the attainment of full maturity, therefore when a stock is reduced to a few individuals, few young will survive, except in very favourable circumstances. If such circumstances do not arise during the life of a surviving small stock, that stock will die out in that locality, whether it be oysters, sea-urchins, sea-hares, ascidians, or other sedentary or semi-sedentary forms; fishes—not being sedentary animals—fall in a different category.

In order that a stock may be maintained in a certain locality, it would seem that a certain minimum number of individuals, which may be relatively large, is necessary. It may reasonably be assumed that a fairly constant proportion of larvæ will

perish either from a multitude of enemies or unfavourable physical conditions, whether the total number be high or low ; but if the number of larvæ be very low, there is a greater chance that all will perish. The conception that a minimum stock is necessary to maintain a species in a given locality thus arises. In the absence of any data on the problem, the economic limit of dredging has been suggested[1] as a practical minimum in the case of the oyster. The economic limit on the poorest English grounds works out at that state of the beds when about 50 to 100 adult oysters may be dredged per man per boat per day. With lower standards of living, or with very high prices, the economic limit may fall below this density. To-day the minimum stock necessary to ensure survival may therefore be estimated above rather than below the economic limit of dredging, as stated above, especially in localities where pollution is an increasing menace, since in the past the economic limit has not sufficed to ensure revival. In any event the careful cultivator will endeavour to maintain as large a stock as possible on the beds during the spawning season.

At the present day the spectre of pollution as a factor in diminishing or even preventing a spatfall, by destroying the larvæ, is probably in the background of the minds of most oyster producers. Oils are especially regarded with grave suspicion ; but the small quantities of these substances relative to the volume of water with which they are mixed, and the small quantities of toxic ingredients in oils, renders it extremely doubtful that they alone can have any poisoning effect in *sea*-water. There is, however, the broader aspect of general pollution to be considered. The additive effect of all the poisonous substances in the drains and sewers from industrial effluents especially—besides which tar and oils may be relatively unimportant—may be that of producing a very slightly unfavourable environment at first in a very small zone near the source of the effluent. This slightly unfavourable environment may be such as cannot be detected by any known method, and may result in forcing seawards the more delicate of the marine organisms. In many estuaries there can be no doubt, as Hautreaux (*Bull. Soc. de Géog. Comm. de Bordeaux*, II, 18, Bordeaux, 297, 455 ; 1895) long ago suggested, that the water oscillates up stream and down to a great extent as a result of the piston-like action of tidal waters outside ;[6] the movements of shoals of estuarine crops of the jelly-fish, *Aurelia*, for example, in the Hamoaze, Cornwall, and R. Blackwater, Essex, offer a simple means of observing this oscillation. Thus polluting substances or their products will tend to increase in such an oscillating body of water, especially between spring tides. Whether such a net pollution ever attains to lethal importance for the more delicate animals, such as oysters, in any particular locality is a legitimate subject for research, which, however, involves fundamental studies of the constitution of sea-water. All coastal waters must be regarded as polluted—using the word in a general sense—in comparison with oceanic water, and the degrees of pollution of coast and estuarine waters may be more readily determined by comparison of their fundamental properties with the purer medium. The oyster cultivator will therefore welcome all schemes for the investigation of pollution and the maintenance of purity in estuarine waters.

Indeed, economic problems regarding oysters and oyster cultivation are so bound up with those in general biology that extensive co-ordinated researches prosecuted on the lines advocated in NATURE, **122**, p. 311, would serve both biological and economic aims, and might be the beginning of a new phase in British marine biological research.

On the economic side, it will be obvious from the account given above, and in NATURE, Feb. 9, that the oyster cultivator requires a long lease of the ground it is proposed to cultivate. Existing fishery rights must be acknowledged, and if necessary dredging rights of local fishermen may be accommodated by an allotment of shares in the new schemes.[7] In ventures in which the cultivator cannot expect to produce young oysters, that is, on purely fattening beds, State assistance cannot reasonably be expected. But where conditions are deemed favourable for the development of a new area for the production of young oysters, State aid in the early period of development may perhaps be reasonably asked for. In beginning a scheme for the production of oysters in a new locality, a fresh attempt is in fact being made to supply the raw material of an industry. In this respect oyster production is roughly analogous to beet production.

FIG. 1.—Output of oysters (mainly *O. edulis*) from oyster beds in the British Isles for the period 1911–27 (according to statistical returns). No records were kept in Great Britain during the European War.

New ventures which aim merely at fattening oysters will have to compete with well-established merchants, who on one hand are expert in their business, but on the other hand do not appear

to be able to meet the demand. In new producing areas the essential characters of the grounds include:

(1) Estuarine waters sufficiently enclosed—in a technical sense—to ensure the retention of the larvæ and spat in a maximum area under cultivation.

(2) A local seasonal temperature range giving frequent probabilities of a maximum temperature in the bulk of the sea-water of 64° F. or more, and a minimum rarely below 34° F.

(3) A large area of moderately clean ground, and moderately pure water which should not fluctuate greatly, nor fall much or often below 2·5 per cent, in saltness.

(4) A sufficient stock of large oysters to supply probabilities of an increasing spatfall year by year.

(5) A supply of cheap clean shell or other material for the annual sowing for spat.

(6) Reasonable shelter from gales, if much sandy or fine gravelly ground occurs in the locality.

(7) Immunity from gross sewage or industrial pollution now and in the fairly distant future.

(8) Absence of an abnormal amount of enemies or pests.

A review of these characters indicates that the southern regions of England and Ireland are most likely to yield new producing grounds, whilst a glance at Fig. 1 suggests that potentialities for production in Ireland are undeveloped to a greater degree than in England.

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Vibration in Bridge Structures.[1]

Bridge building may be reckoned amongst the earliest of the structural engineers' efforts, and locomotive construction as one of the first lines of development in mechanical engineering; but the adequate study of the actions of a locomotive on a bridge has required very modern resources in investigation, and all those refinements of experimental and analytical methods that mark the engineering technique of to-day. The problem in its various aspects and complexities has been very completely studied, with the aid of these resources, by the special Bridge Stress Committee appointed by the Department of Scientific and Industrial Research in 1923. The Committee comprised highly representative scientific and technical engineers, under the chairmanship of Sir J. A. Ewing, of the University of Edinburgh, and the full report of their deliberations and investigations has now been published. The remit of the Committee was "to conduct researches with reference to stresses in railway bridges, especially as regards the effects of moving loads." These comprehensive terms of reference have been very adequately interpreted, and the work of the Committee constitutes an invaluable study of the vibration of bridge structures under impact influences. Work with a somewhat similar motive had previously been attempted—notably by the American Railway Engineering Association in 1910, and by a special committee of the Indian Railway Board in 1917—but the present report goes much further and deeper into the subject.

The previous investigations had made fairly clear that the main cause of serious augmentation of bridge stresses arose from the unbalanced vertical forces developed by the locomotive. Certain effects could be traced to rough and flat wheels, irregularities of track, or to heavily loaded freight cars, but these were usually small in relation to the direct consequence of the pulsating force—or 'hammer blow'—due to the 'balance' weights on the locomotive wheels. While this was recognised, it has not been very effectively embodied in bridge stress rules; and, as in the well-known Pencoyd formula, the influence of impact is generally covered by a proportionate increase, varying with span length, of the live load stress. If impact is mainly due to locomotive actions, this process of making allowance on total live load is scarcely rational. It is the achievement of the Bridge Stress Committee that it has not only clearly elucidated the nature and cause of impact, but that the investigation is so complete as to permit of the standardisation and rationalisation of impact allowances in general.

An ordinary two-cylinder locomotive is balanced by the locomotive engineer by the addition of weights to the rims of the driving wheels. But this is merely a process of reducing the inertia force effects in the engine lines. What is eliminated in those lines is transferred by the so-called 'balance weights' to the vertical plane; and hence variation of horizontal force is changed to a vertical fluctuation giving rise to a pulsating force on the rails. The magnitude of this force is all-important. The report repeatedly refers to it; and it is recorded that the locomotive engineers of Great Britain are prepared to limit its value to a total per locomotive of $12\frac{1}{2}$ tons at 5 revolutions per second of the wheels. It is, therefore, clear that the importance of the absolute value of this force as a factor in girder stresses is established and accepted. The context also explains that, while in some centres special care is taken to test the balance of locomotives after construction, in other cases more attention is required in this matter. It is also obvious that three- and four-cylinder, and electric locomotives, in which a much higher degree of balance is possible, have distinct advantages over the more common two-cylinder type.

The Committee's work consisted of the actual observation of bridge vibrations and the analysis

(*Continued on p.* 463.)

[1] Department of Scientific and Industrial Research Report of the Bridge Stress Committee. Pp vii+215. (London: H.M. Stationery Office, 1928.) 18*s*. net.

Supplement to NATURE

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Greenland: as it is and as it was.[1]

By Prof. A. C. Seward, F.R.S.

IT would not be inappropriate to take as a text for this lecture words borrowed, with a slight modification, from one of Thomas Hardy's novels: "The past seizes upon us with its shadowy hand and holds us to listen to its tale." One of my aims is to recall a few scenes — in particular, one scene —from a past separated from the present by an interval measured in millions of years, and by so doing to illustrate an impressive contrast between what is and what was. A comparison of a small area of Greenland as it appears to-day with the same district as it was at a time roughly corresponding to the stage in geological history represented by the chalk cliffs of England, affords a startling proof of the changing face of the earth and illustrates the fascination and the stimulus inseparable from every honest endeavour to read the secrets of the rocks.

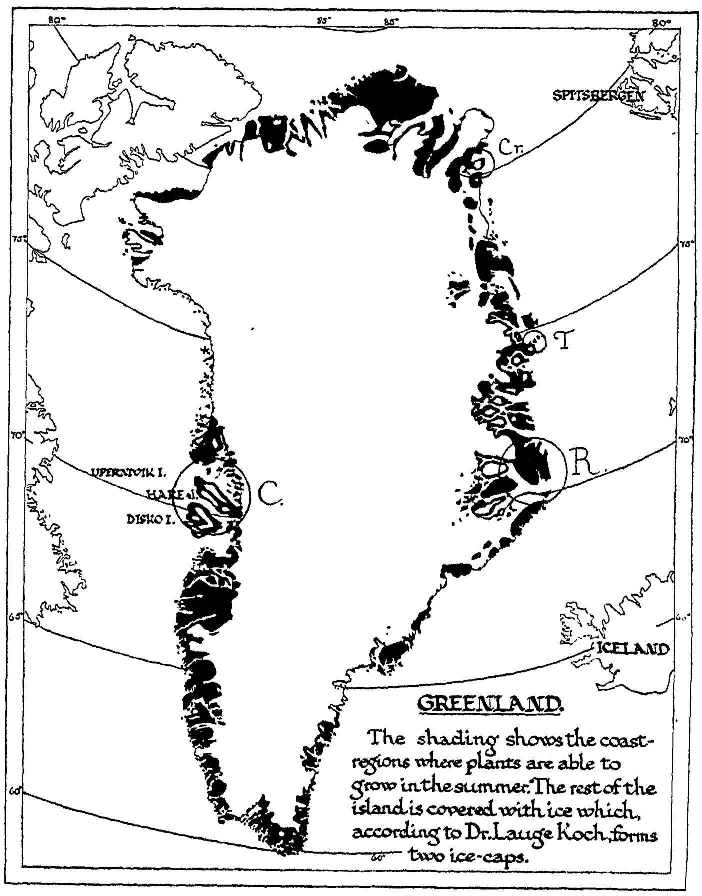

Fig. 1.—Greenland. C, region where Cretaceous and Tertiary plant-bearing beds are exposed. Cr, locality where a few Lower Carboniferous plants have been collected; T, Sabine Island (Tertiary plants); R, Rhætic plant-beds in the Scoresby Sound district.

Physical and Geological Features.

We will first look at Greenland as a whole. Cape Farewell, the southern apex of the wedge-shaped island, an island large enough to rank as a continent, is approximately on the same parallel as the southern part of the Shetland Islands and as Finland. The broad base of the inverted triangle, the most northerly land in the world, reaches lat. 83° N.; the length is nearly 1700 miles and the breadth in the middle is rather more than 600 miles. Greenland is a relatively stable land, one of the oldest pieces of the earth's crust severed from an inconceivably ancient continent which once united the west and the east. By far the greater part of the island consists of crystalline rocks of the type we see in the Norwegian mountains and in the north-west Highlands of Scotland. In the course of ages, Greenland rose and sank with recurrent pulsations of the crust, but the movement was comparatively slight; the sea only partially transgressed the land and advanced farther towards the feet of the mountains.

Of these oscillations there is evidence in sandstones and other sedimentary rocks which at several places on the coastal fringe lie on the eroded platform of the original foundations. The cliffs of Washington Land on the north-west coast are rich

[1] Friday evening discourse delivered at the Royal Institution on Jan. 25.

in marine fossils; in places the abundance of corals led the Danish geologist Lauge Koch to describe them as veritable 'coral reefs.' Near the north-east corner of Greenland some fossil plants were found in sediments deposited in the early days of the Carboniferous period. Farther south, at Sabine Island, other sedimentary rocks have yielded impressions of leaves scarcely distinguishable from those of the existing maidenhair tree (*Ginkgo biloba*), with fragments of other plants of Tertiary age. Still farther south in the district of Scoresby Sound a rich Rhætic flora has been discovered, a flora no less luxuriant than floras of the same age from much more southern countries. The plant fragments were transported by rivers turbid with sand and mud to a delta encroaching over the waters of an estuary at a period between that represented by the still older Triassic salt-bearing marls of Cheshire and the younger Jurassic strata exposed on the Yorkshire coast. There are also more ancient sedimentary rocks not far from Cape Farewell. Special attention will be given in the latter part of the lecture to the remains of a vegetation scattered through sandstones and shales deposited in an estuary during the first half of the Cretaceous period and now accessible in the cliffs of Disko Island, Upernivik Island, and the mainland about half-way up the west coast. This flora is selected in illustration of the contrast between the present and the past to which reference has already been made.

The solid land is seldom stationary; we think of it as permanent, but intensive study of most regions demonstrates the fallacy of conclusions drawn from general impressions. Observations made over a series of years in the latter part of last century show that a section of the west coast is now sinking; the brown seaweeds are slowly creeping up the face of the cliffs. The Cretaceous plant-bearing beds are occasionally overlain by strata of Tertiary age, some of which are rich in plants. Both Cretaceous and Tertiary rocks are protected by superposed layers of basaltic lava and volcanic ash—Arctic outliers of the great volcanic plateau of which there are other relics in the Giants' Causeway and on islands off the west coast of Scotland. Such are some of the documents, differing widely in geological age, which tell of recurrent changes of level and supply the means of interpreting the "ghostly language of the ancient earth."

A word on the human inhabitants: there are about 20,000 Eskimo, most of whom live on the west coast. There is a fairly large colony a short distance from Cape Farewell on the east coast, and in 1925 one or two new settlements were established in the neighbourhood of Scoresby Sound. More than 900 years ago, Eric the Red, taking with him about a hundred companions, with sheep and oxen, sailed from Iceland and founded colonies near the south end of the west coast of Greenland. In 1721 Hans Egede sailed from Bergen and accomplished what has been called the re-colonisation of Greenland; he went there as a missionary in the hope of finding some descendants of the earlier Norse colonists; he found only graves and ruined buildings. In recent years many other traces of the early settlers have been discovered by Danish antiquarians. In addition to the Eskimo there are a few Danish officials. Under Danish rule the condition of the natives has been greatly improved; they can now obtain the necessaries of life whether hunting is good or bad. Dogs used for drawing sledges in the northern half of the country are important and, indeed, essential companions to the inhabitants; in summer they are usually left to fend for themselves; in winter they become efficient servants.

Greenland under an Ice-Sheet.

The outstanding feature of Greenland is the inland ice. With the exception of a coastal strip along most of the west coast, a relatively broad strip on the extreme north, and a narrow margin on the east, the whole of the island is hidden under ice of unknown thickness which forms a gently sloping dome rising in the interior to a height of at least 9000 ft. Here and there on the lower slopes of the ice-sheet, summits of mountains project as solitary islands above the "waste of frozen billows." These are spoken of as 'nunataks,' a name suggested by Nordenskjöld. Sailing up the west coast in summer, one sees the ice-free edge of a plateau rising to a height of a few thousand feet, the cliffs intersected by many tortuous fiords, and, on the seaward side, groups of rocky islands with the rounded contours characteristic of ice action. An occasional white gleam above the dark cliffs of the mainland comes from the edge of the inland ice. Some glaciers creep into the open sea; others enter the deep water of fiords several miles from the coast. From one glacier at the head of the ice fiord near Jakobshavn (lat. 69° N.) are calved many of the icebergs which are carried by currents to the Newfoundland banks and much farther south; many are stranded on shallows off the Greenland coast. Near the land the sea is littered with icebergs of all shapes and sizes; their sunlit sides and pinnacled summits are radiantly white, and near the surface of the water a brilliant blue-green. In the stillness of the night

the sudden booming of breaking bergs recalls Coleridge's description in "The Ancient Mariner": "the ice did split with a thunder fit." Some of the larger icebergs reach a height of 200 ft. above the water, and the submerged portion is approximately eight times as deep as the height of the visible berg.

The jagged Alpine peaks of the higher mountains of crystalline rock, which are especially impressive as seen off Upernivik Island, are in marked contrast to the flat-topped basaltic hills of Disko Island and the adjacent Nugsuak Peninsula (Fig. 2). Before passing to the consideration of the fossils preserved in the sediments below the basalt, we will take a general view of the vegetation which partially clothes the ice-free coastal belt.

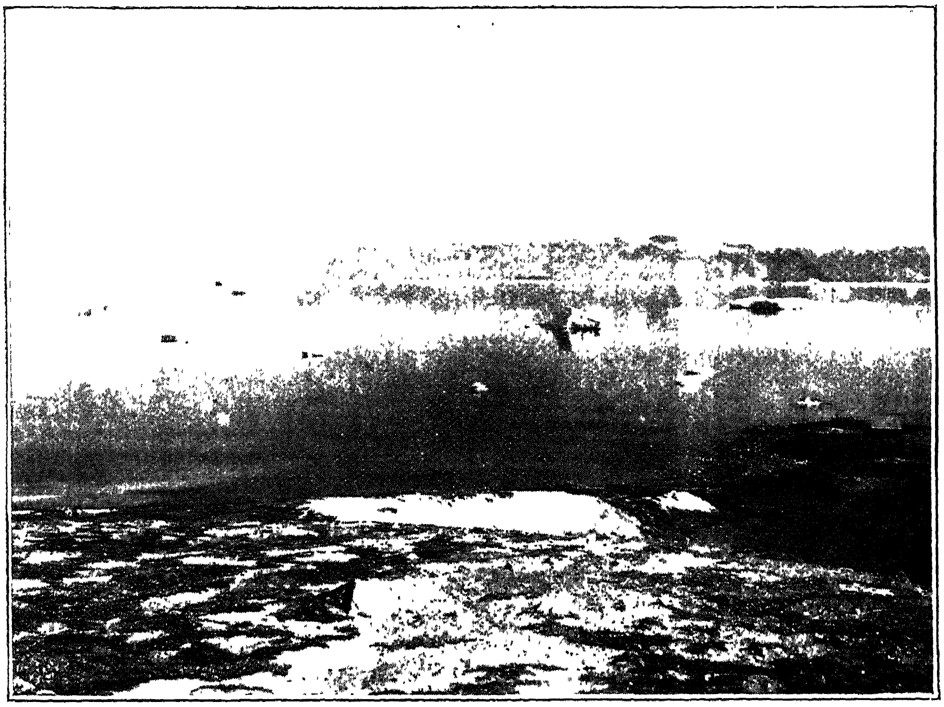

FIG. 2.—Basalt-capped hills of the Nugsuak Peninsula seen from Disko Island. (Photo. by R. E. Holttum.)

THE PRESENT VEGETATION OF GREENLAND.

From the whole of Greenland, 390 species of vascular plants, that is, flowering plants, conifers, and members of the class to which the ferns belong, have been recorded. The tree-limit, which is taken as the southern boundary of Arctic vegetation, is close to Cape Farewell; in south Greenland there are birches, alders, and a few other trees, some reaching a height of 12 ft. or 18 ft. Farther north in the region of Disko Island, the only representatives of trees are dwarf shrubby willows and the dwarf birch; the tallest willows rarely exceed three feet. The prostrate shoots bear an amazing number of catkins; their roots spread far in a horizontal direction through the shallow soil (Fig. 3). The ground is permanently frozen at a depth of rather more than a yard. A reflection of the severity of the life conditions is seen in the internal structure of a willow stem; in a section of a stem less than an inch in diameter fifty rings were counted. Lichens play a prominent part in the landscape and in preparing the ground for higher plants; tufts of white, yellow, and grey, with splashes of vermilion, give colour to tundra and rock. It is worthy of note that about half of the lichens obtained from the Antarctic continent belong to species recorded also from Arctic lands; these wind-borne plants are probably the greatest travellers of the plant kingdom. The green ribbons marking the course of streams owe much of their brilliance to mosses.

There are a few ferns, some growing in rock fissures, some in company with flowering plants in favoured situations: *Cystopteris fragilis*, the brittle fern, is one of the most cosmopolitan of plants; it grows in Spitsbergen, in Chile, Abyssinia, on Kilimanjaro, and in the sub-Antarctic island of South Georgia. There is also the holly fern *Polystichum Lonchitis*, a European species which flourishes in central Asia and in the southern hemisphere. Reference may be made to two other plants which belong to the fern class and are very widely distributed: *Equisetum arvense*, the common horse-tail, and a club moss, *Lycopodium Selago*.

Turning to the flowering plants, which give to the Arctic landscape an unexpected brightness, a few examples must suffice. The Monocotyledons include several grasses, sedges, and rushes; species of pondweeds (*Potamogeton*) and a few forms of cotton grass (*Eriophorum*). On a sunny slope on the shore of Disko Island there are a few orchids (*Habenaria* and *Listera*) and other plants which have been able

to occupy this exceptionally favoured station many miles north of their normal range. The tallest flowering plant is *Archangelica*, an Umbelliferous genus prized as a delicacy both by the Eskimo and sophisticated Europeans. The large rounded leaves of an *Alchemilla*, closely allied to the British lady's mantle, come next in size to those of *Archangelica*.

There is much heath land, but the heather and ling which we associate with heath moors are absent; their place is taken by *Cassiope tetragona*, characterised by the grooved leaves in four crowded ranks and yellow flower bells. *Cassiope* grows in Scandinavia, though not elsewhere in Europe, in the Rocky Mountains, and in central Asia. The crowberry, *Empetrum nigrum*, associated with the bilberry, is a common Arctic plant which has wandered as far as the southern end of South America. Saxifrages are abundant; the flowers of the purple saxifrage, *Saxifraga oppositifolia*, are an exception to the prevailing white. This species, one of many common to Greenland and Britain, occurs with other plants on the north coast of Greenland up to lat. 83° N.; it grows also on the higher slopes of the Himalayas. *Dryas integrifolia*, an American species differing but little from the British *Dryas octopetala*, is a conspicuous member of the west coast flora: *Dryas octopetala* is characteristic of the north coast and eastern Greenland. The familiar and always attractive hare-bell, *Campanula rotundifolia*, seems to be as much at home on the hills of Greenland as it is in England, in North Africa, and the Far East. Among other plants are the mountain sorrel *Oxyria digyna*; the moss campion, *Silene acaulis*, which is one of several cushion plants characteristic of rocky places; a closely allied plant, *Melandrium apetalum* (or *Lychnis apetala*); the yellow poppy; a species of *Pyrola* (the Labrador tea); *Ledum*, with its white sweet-scented flower heads, exceptional in a flora composed almost entirely of scentless flowers; also a willow herb with flowers larger and handsomer than those of our British species.

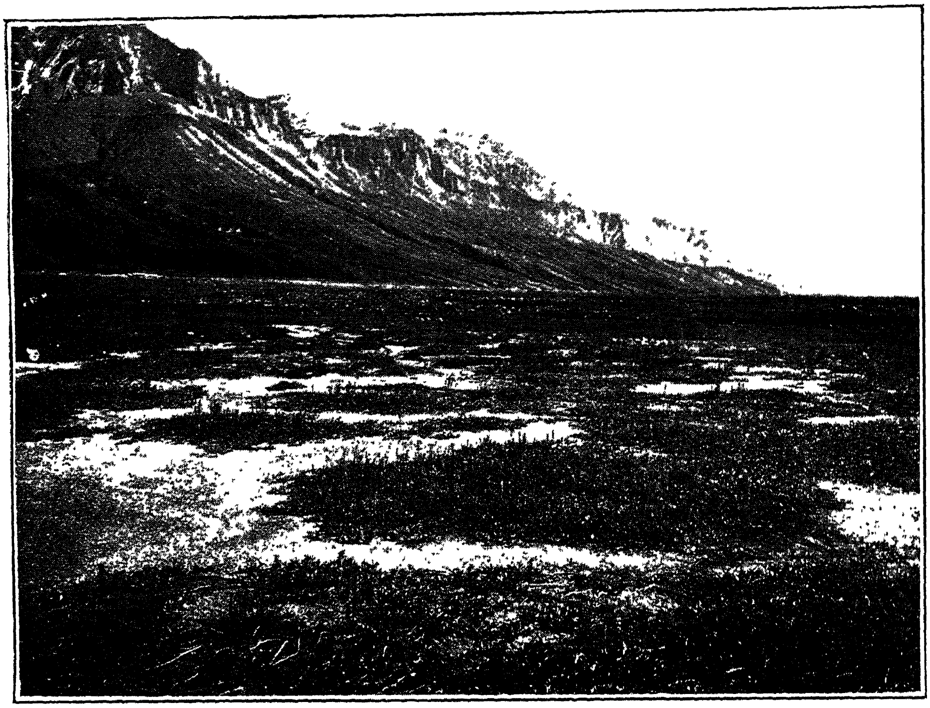

FIG. 3.—Willows and other plants on a delta below the cliffs of the Nugsuak Peninsula. (Photo. by R. E. Holttum.)

My main object is to give a general impression of the more obvious features of the present vegetation, not to describe many individual plants. A Scottish mountain with many immigrants from Arctic lands reproduces in broad features the Greenland landscape; but there is this difference: the mountain flora in Greenland reaches the coast and there is no intervening belt of forest and meadow. The mean temperature for July in lat. 69° N. on the west coast of Greenland is 47° F.; the corresponding temperature in the London district is 60° F.; in February the mean temperature in Greenland is 36° below freezing-point; in London it is 10° above the freezing-point. It is not until the temperature rises above the freezing-point that the plant world becomes active: in the extreme north the growing season lasts barely two months; it is only in July that rain takes the place of snow. In the region of Disko Island the summer season is not much longer. The summer is a period of concentrated effort; there is no time for the leisurely sequence of plants that bloom early and plants that bloom late. The unfolding of buds prepared in the previous year before the incidence of the winter sleep heralds the rush of new life with an almost explosive suddenness. Short

as the summer is, the plants succeed in spreading a parti-coloured carpet over hill slopes and valley, and in decorating rock ledges and fissures. A brilliant summer display is followed by a "rich autumnal melancholy": the ground is strewn with deep red and orange-yellow leaves which are soon to form a welcome blanket, aided by the snow which quickly follows, above the shoots entering on the long winter's rest.

Of the 390 vascular plants, Prof. Ostenfeld of Copenhagen thinks that about 13 per cent may have been introduced by the early Norse colonists; of the remainder, by far the greater number came from North America by way of the narrow channels separating the American archipelago from the north-west corner of Greenland. A smaller number travelled from Europe, some driven by wind, the passage probably facilitated by a frozen sea, others carried by birds.

Greenland as it is enables us to picture the British Isles in the grip of the Ice Age, at a time separated from the present by a comparatively short interval as geologists reckon time—say 40,000 years. We know that the flora of Britain, as also that of northern Europe generally, was much richer in Arctic forms than it is now. To give one example: from thin layers of peaty material in a gravel pit close to Cambridge, several Arctic species associated with more southern types have been identified, a mixture very similar to that in the present Greenland flora. When the Glacial period was at its height, the conditions in Greenland were even more severe than they are now; it is believed by some botanists that the whole of the vegetation colonised the land after the Ice Age had passed its climax. The entire vegetation, it is suggested, must have been destroyed. On the other hand, the occurrence of flowering plants on the northern border of Greenland and of some species on wind-swept island peaks above the level of the inland ice, gives support to Prof. Ostenfeld's view that a small proportion of the present flora survived the great ordeal. It is highly probable that, as in Greenland to-day, a comparatively rich flora is able to exist on the ice-free margins and on nunataks; so also when the British Isles were as Greenland is now, there must have been sheltered places which served as refuges for the hardier member of the pre-glacial vegetation.

Many Greenland plants have a circumpolar distribution; some are exclusively or mainly Arctic; others, though widely spread in Arctic regions, are established also in more southern stations. A southern migration from the far north was caused by the gradual extension of the ice; the majority of the plants, unable to endure the increasing hardships, were driven to alien lands and a few crossed the equator. When the ice retreated and the temperature rose, some of the travellers returned to the north; others found congenial habitats in the colder climate on mountain slopes. A few of the Arctic plants held on to life in their original homes as a small nucleus-company in sole possession of a territory temporarily deserted by most of the former occupants.

We have noticed the circumpolar range of many members of Arctic floras, and we have seen that some species are able to exist even on the northernmost edge of Greenland which looks out over the abysmal Polar sea. Turning to the Antarctic continent, we find an amazing contrast: flowering plants are unrepresented on the great mass of land surrounding the South Pole, even though its coast-line occupies a position where in the northern hemisphere there is a comparatively rich flora. Two flowering plants have been found south of lat. 60° S., in South Georgia (corresponding roughly in latitude with the British Isles), the South Shetlands, and Graham Land.

The Cretaceous Vegetation of Western Greenland.

We will now visit the cliffs and ravines of Disko Island, Upernivik Island, and the adjacent mainland, and glance at some of the fragmentary samples of the Cretaceous flora embedded in the mud and sand of an old river delta. We pass over the ages intervening between the maximum glaciation during the Ice Age, which antedates the present by some 40,000 years, to the early days of the Cretaceous period, separated from us by perhaps a hundred million years. Among the fossil ferns, by far the most abundant genus is *Gleichenia*, or *Gleichenites*—to use the name generally applied to extinct species. Many of the fronds are fertile, and it is possible to examine under the microscope the structure of the spore-capsules. The habit of the leaves and the structure of leaf-stalks and sporangia afford convincing evidence of close relationship with species of *Gleichenia* which are now among the more familiar ferns in the tropics. *Gleichenia* is unknown in Europe. Another type of fern (*Laccopteris*) is represented by fronds characterised by spreading finger-like branches set with long and narrow leaflets which agree closely with those of the Malayan genus *Matonia*. Similarly, a few specimens have been obtained which present a striking resemblance, in form and venation, to fronds of another Malayan and Indian genus, *Dipteris*, a plant described by

Alfred Russel Wallace as growing, in company with *Matonia*, on the higher slopes of Mount Ophir in the Malay Peninsula.

Leaves, twigs, and occasional petrified stems of conifers are fairly common. To-day there are no conifers in Greenland north of lat. 67° 50′ N., the northernmost limit of the juniper. Petrified stems of conifers rival in size the trunk of a well-grown fir, and the annual rings, in marked contrast to those in the dwarfed stem of an Arctic willow, are comparable in breadth with the rings in an English tree. Some conifers are represented by innumerable fallen leaves recalling the leaf carpet in a modern forest. Imperfectly preserved leaves are untrustworthy as criteria of precise affinity, but such characters as can be made out suggest relationship with the umbrella pine (*Sciadopitys*) of Japan. Twigs and occasional cones bear testimony to the occurrence in the Greenland forests of trees akin to the redwoods and mammoth trees which are now restricted to a narrow territory in California. Other conifers resemble cypresses ; and there is some evidence of the presence of trees allied to existing Araucarias.

Two other groups of naked-seeded plants (Gymnosperms) are represented : broad, wedge-shaped leaves with the blade cleft into two or more segments differ in no essential respect from the foliage of the maidenhair tree, the solitary survivor, and that only through the care of man, of a class which once overspread the world. The second group is the Cycadophyta, another branch of the plant kingdom which for long ages, in the Mesozoic era, was one of the ruling dynasties and is now represented by a comparatively small family, the cycads or sago palms, which are mainly tropical and reach their northern limit in Florida. It is unlikely that the Cretaceous fossil fronds, despite their general similarity to those of living genera, were borne by plants closely related to the true cycads ; they probably belonged to species of a wholly extinct section of the group.

Finally, we come to the flowering plants : the Cretaceous representatives of the class which is now dominant in the plant kingdom were trees, not low-growing shrubs or perennial herbs. By far the commonest tree, or at least the tree which has left the most abundant traces, seems to have been the plane, represented by several forms. It must be remembered that the available material, largely consisting of detached leaves, is a small collection of scraps ; a random choice of the winds which swept broken twigs and leaves into the waters of a river carrying to its delta a burden of sediment and vegetable debris, records destined to serve as a source-book for historians of a future age. Our conclusions are based on scraps of evidence, and the only plants we know are such as came within the reach of the agents which caused their preservation. In form, in venation, and in size, the leaves of the Greenland planes are scarcely distinguishable from those of trees now living in Mexico, in Greece, and Asia Minor. A type of leaf that is abundant at certain localities was for many years believed to belong to a tree nearly related to the tulip tree (*Liriodendron*) of North America and China.[2] The examination of more recently collected specimens has confirmed a previously expressed suspicion that the supposed *Liriodendron* leaves are not complete leaves but leaflets from the foliage of trees nearly related to the tropical genus *Dalbergia*, a member of the Leguminosæ. Some years ago the late Prof. Nathorst of Stockholm described specimens of large leaves and pieces of inflorescence presenting an unmistakable resemblance to the leaves and flowers of *Artocarpus*, the tropical bread-fruit tree. Some smaller examples of the same type were collected in 1921. The Cretaceous vegetation included other broad-leaved trees : magnolia, oak, trees related to members of the Laurel family and to species of the family Menispermaceæ now mainly tropical in distribution.

It is possible with the help of a little imagination to reconstruct a scene in Cretaceous Greenland. Across a broad estuary in summer, a range of mountains on which patches of winter snow are still unmelted ; in the foreground maidenhair trees, conifers foreshadowing pines, cypresses, araucarias, and other surviving members of the Gymnosperms. There are also many ferns, a few with erect stems, many with creeping rhizomes bearing long-stalked and repeatedly forked fronds, others with leaves divided into long, narrow arms. Among the broad-leaved trees are several planes, an oak, a magnolia in flower, trees with the foliage of dalbergias, the cinnamon, and trees belonging to families which since the Cretaceous period have wandered through Europe and the greater part of the North American continent, some surviving only in the southern tropics.

Fossil Plants as Evidence of Climatic Change.

An uncritical or superficial comparison of the Cretaceous vegetation with that in the Arctic regions at the present day would seem to necessitate

[2] In a book, "A Summer in Greenland," published by the Cambridge University Press in 1922, I referred to these leaves as *Liriodendron* ; this mistake was corrected in the description of the Cretaceous flora published in the *Philosophical Transactions of the Royal Society* in 1926.

the inference that the Cretaceous climate must have been tropical. Some of the ferns and other plants obtained from the Greenland rocks have been compared with species that are now mainly tropical in distribution. Let us consider more closely the evidence and the conclusions which may legitimately be drawn from it. It is true that the existing species of the fern *Gleichenia* are for the most part tropical; on the other hand, the genus occurs in the Far East north of lat. 30° N. and extends a short distance north of lat. 20° N. in North America. Moreover, the occurrence of species at an altitude of more than 12,000 ft. in New Guinea and above 10,000 ft. on Ruwenzori in tropical Africa shows that the genus is able to tolerate conditions that are by no means tropical.

One of the most remarkable instances of the presence in the Cretaceous flora of a plant that is now tropical is furnished by *Artocarpus* (Fig. 4). The genus *Dalbergia* affords an almost equally striking contrast in geographical range. The present distribution of *Magnolia* in both the Old and New Worlds is far to the south of its former range. The plane tree (*Platanus*) now flourishes in temperate regions, in Greece and Asia Minor, and in America it passes north of lat. 40° N. The genus *Ginkgo* flowers freely in the south of France; in England it is comparatively hardy. The present geographical distribution of such Greenland Cretaceous genera as are now represented by existing species would seem to indicate a climate in the Arctic regions not less genial than that in southern Europe at the present day. The important point is the value to be attached to this kind of comparison. We know that closely allied species often grow in regions differing considerably in mean temperature.

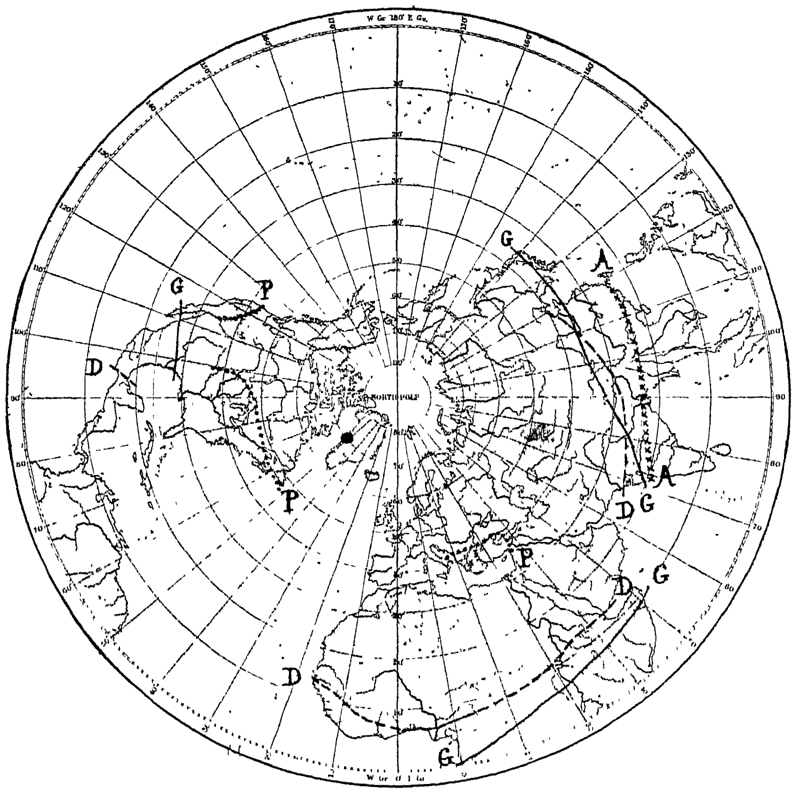

FIG. 1.—Map showing the approximate northern boundary of the area of distribution of living species of the following genera: A, *Artocarpus*; D, *Dalbergia*; G, *Gleichenia*; P, *Platanus*.

A further point is, ought we to assume that plants have remained unaltered in their constitution, in the sensitiveness of their living protoplasm, to the effects of cold and other external influences? It is surely rash to assume that in the course of ages there has been no change in the degree of response to factors which govern existence. My own view is that the practice of employing plants, especially extinct plants, as guides to temperature in the past, has been carried too far. There can be no doubt that, when the Cretaceous vegetation covered the western glens of Greenland, the climate must have been very much more genial than it is now; we cannot usefully attempt to estimate the difference in degrees of temperature. How can the difference be explained? The often-repeated proposal to assume movements in the position of the earth's axis—a shifting of the poles—even were there adequate grounds for the assumption, would not provide a satisfactory solution. Astronomers offer no encouragement to geologists prepared to take liberties with the axis of the earth. It is certain that the boundaries of land and sea, the height of the land as well as the area, have changed from age to age and that climatic conditions have correspondingly fluctuated. Changes in the relative position of land and water, such as we can legitimately postulate, would go some way towards provision of the environment demanded by the Cretaceous vegetation; but it is the opinion of some meteorologists that we cannot solve the problem on these lines.

The publication of Wegener's views on continental

drift, the shifting of continental masses by the slow drifting apart of slabs of land detached from a once continuous surface, seemed to offer a possible way out of the difficulty created by the occurrence of fossils in places where their presence has long been a puzzle to geologists. We may hope before long to have trustworthy data by which to test the value of Wegener's hypothesis. It is tempting to imagine Cretaceous Greenland lying many degrees south of its present position. The close correspondence between the Rhætic flora obtained from Scoresby Sound and that discovered some years ago in southern Sweden, and a similar agreement between the Arctic flora and floras preserved in rocks of the same age in Maryland and Virginia, in Bohemia, and elsewhere, almost persuade us that we are most likely to solve the problem by regarding the earth's crust as a collection of blocks floating on a heavier substratum, some of which have wandered far from the positions they once occupied. Evidence in support of changing climates is as strong as evidence can be, but we are still groping for satisfying explanations. It may be that no explanation can be found unless we adopt the Wegener hypothesis or some modification of it.

On the other hand, it is difficult to believe that the greater part of Greenland in the Cretaceous period was not, as it is now, well within the Arctic circle. Until we have convincing evidence of drifting continents, the question of how the problem of climatic change is to be solved must be left unanswered. Assuming an Arctic Cretaceous Greenland, it follows that the luxuriant vegetation must have been able both to lie dormant during the long winter night and to accomplish the miracle of reclothing the earth in the course of the short summer aided by an ever-present sun. This unavoidable conclusion, though difficult to accept, is perhaps not beyond the range of possibility.

Though we leave unsolved problems raised by the contrast which it has been my aim to illustrate, we have obtained an insight into the methods of deciphering the records of the rocks, records which enable us to reconstruct some of the sharply contrasted stages in the history of an ever-changing world.

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of the records therein obtained. The gross total of the work in the field and in the office is enormous; but the subsidiary work called for in the study of vibration instruments and their accuracy, special small-scale laboratory tests, the development of a bridge-oscillating machine, and the theoretical investigation of bridge vibrations, are all of considerable scope and important in themselves. Indeed, the analytical work of Prof. Inglis is already well known as a research of special distinction; but although it had been, in the main, separately and previously published in special papers, its function in guiding the investigation is only now clearly seen through its relation to the complete report.

The pulsating forces from the locomotive wheels create regular impulses on the structure during passage. If these are in agreement with the natural frequency of the bridge, large vibratory amplitudes may ensue as a result of resonance. The work of investigation, then, entailed the measurement of natural frequencies with the bridge loaded and unloaded; and the observation and recording of the deflections with the locomotive passing over, first at very low speeds, and then at speeds at and around resonance. Examinations were carried out on 52 bridges varying in span from 16 ft. to 345 ft. The locomotives were provided by the railway companies, who throughout co-operated with the Committee. All types were represented. In many cases the engines were specially chosen for the large hammer blow which they developed, so that the worst possible conditions could be fully observed. The total amount of information gathered, and the wide range of spans dealt with, full particulars of which are given, certainly permit of important conclusions which should prove thoroughly reliable in the guidance of bridge design.

The limitation of the amplitude of vibration in any case is partly an effect of damping; and in this connexion the interesting work on the influence of the locomotive springs should be noticed. There is apparently a pair of critical speeds depending on whether the suspension springs are in play or not, the probability depending on whether the oscillations of the bridge are sufficiently great to overcome the spring friction. Apart from damping, however, the span length is an all-important factor. With short spans the natural frequency is too high to be equalled by the locomotive speeds. With very long spans, on the other hand, the natural frequency agrees with low locomotive speeds, when the impulses are relatively small. To deal with these different effects the Committee develops a 'dynamic magnifier,' a multiplier akin to the usual amplification factor of vibration theory, which expresses the ratio of the vibration amplitude to the deflection that would be caused by a static load equal to the hammer blow. This factor is first developed for the synchronous condition for all spans and then corrected for the interrelations of span length and locomotive frequency. It would appear that spans around 100 ft. are subject to the largest dynamical magnification. The curve for this important factor should ultimately take an important place in bridge design rules.

The report briefly discusses other causes of impact, such as effects of irregularities of track, rail joints, and the 'lurching' of locomotives; and enters at large into the tabulation of loads and allowances for impact. Appendixes on impact formulæ, instruments, balancing of locomotives, etc., are given. The whole report constitutes an impressive compilation of the details and conclusions of a courageous and exhaustive full scale research that reflects great credit on the Committee and its staff.

Obituary.

THE issue of the *Physikalische Zeitschrift* for Jan. 1 contains a photograph and an obituary notice of Prof. A. H. Bucherer of Bonn, who died in May 1927, written by his former colleague, Dr. R. Tomaschek. He was born in Cologne on July 9, 1863, the eldest of six children of H. Bucherer, a chemical manufacturer, and his wife, a musical and highly educated English lady. He was educated at the Cologne High School, where he displayed a gift for languages. After serving his year in the army and spending a year at the Hanover technical school, he went in 1885 to the Johns Hopkins University, Baltimore, where he studied under Prof. Ira Remson, and for a time held a lectureship, then in 1893 to Cornell University, and in 1895 returned to Germany to complete his studies under Prof. Braun at Strasbourg, and took his doctor's degree in 1896. After a further three years at Leipzig under Ostwald, and at other universities, he became a lecturer on physical chemistry at Bonn in 1899. Later he became honorary professor, a post he resigned in 1923. From his youth he showed himself of independent thought, little disposed to conciliate those from whom he differed, and this attitude did not smooth his way in life. He is best known for his "deformable electron" and for his experimental determination of the influence of the speed of an electron on its apparent mass. He was not satisfied with Einstein's relativity theories, and was engaged towards the end of his life in an endeavour to deduce all the results of that theory and remove some of the difficulties it has raised, by a logical development of classical mechanics.

By the recent death of Dr. Franz Oppenheim, announced in the *Chemiker-Zeitung*, Germany has lost one of its leading personalities in chemical industry. For nearly fifty years Dr. Oppenheim was associated with the Aktiengesellschaft für Anilinfabrikation in Berlin, of which concern he was president at the time of its inclusion in the I.G. Farbenindustrie Aktiengesellschaft in 1925. His ripe experience led to his appointment on the board of management of the latter amalgamation. He held several public offices connected with the German chemical industry; for example, he was treasurer of the Emil Fischer Society for the promotion of

chemical research, of the Adolph von Baeyer Society for the promotion of chemical literature, and of the Justus von Liebig Society for the promotion of chemical teaching. Quite recently he had been elected to the committee of the Chemisch-Technische Reichsanstalt in Berlin. He died at Cairo at the age of seventy-seven years.

The death on Feb. 28, at the age of seventy-three years, of Dr. J. Wells, formerly Warden of Wadham College and Vice-Chancellor of the University of Oxford, is felt as a serious loss in many departments of University activity. Though not himself a student of science, he was never unmindful of the scientific traditions of the College over which he presided. It is undoubtedly the case that but for his wise and fair-minded dealing with the matter during his vice-chancellorship, the Lewis Evans collection of scientific instruments might have been lost, not only to Oxford, but to England as well. It should always be remembered that not only this invaluable asset for the history of science, but also many other advances in the scientific equipment of the University of Oxford, owe their efficiency, if not their existence, to the good offices of Dr. Wells.

News and Views.

The fiftieth birthday of Prof. A. Einstein occurred on Mar. 14, and brought congratulations from all parts of the world. The German Chancellor hailed him as "Germany's great savant," and the Berlin municipality gave him the life tenancy of a pleasantly situated mansion. The University of Paris conferred an honorary degree. The Zionists are to plant an "Einstein Wood" near Jerusalem. Never before has the name of a scientific worker meant so much to the average man. Yet the creator of relativity and of the unitary field theory remains a quiet and retiring personality who dislikes publicity and society. His appearance suggests a musician, and indeed his love of music is one of his leading characteristics. Last year he gave a violin recital for a charity. He finds much pleasure in Russian literature, and appreciates modern ideas in architecture. He is an ardent sympathiser with efforts for world peace. Recently his health has not been good, but he says, "Illness has its advantage: one learns to think. I have only just begun to think."

Employers and trade unionists associated under the auspices of the Conference on Industrial Reorganisation and Industrial Relations have recently issued an interim joint report on unemployment. In this report the problem of unemployment is investigated and suggestions made for its diminution. It is pointed out that, since 1920, there have seldom been fewer than a million workers unemployed in Great Britain, while at times the number has exceeded two millions. The heavy industries in particular have been severely hit by the depression, and the activity of certain prosperous industries, such as artificial silk and the motor industry, has not really compensated for this depression in the great basic industries. The report stresses three factors, monetary policy, world economic conditions, and the temporary displacement of labour due to the rapid adoption of labour-saving methods, as being the main causes of the present acute unemployment.

Corresponding to this analysis of the causes of unemployment in Great Britain, the main remedies (that is, apart from immediate or merely palliative measures) suggested in the recent interim report are: *first*, an inquiry into monetary policy with whatever action may be found necessary; *second*, the reorganisation of industry, including rational organisation into larger units and the substitution of modern plant and technique; and *third*, measures to mitigate the evils resulting from rapid displacement of labour. Finally, the novel and interesting suggestion is put forward that a Labour Reserve Fund should be set up either by firms or by particular industries, which fund would be available for the purpose of assisting displaced labour. Progressive firms, it is pointed out, build up special reserve funds (apart from normal depreciation) to enable plant to be replaced before it is worn out, so that the most modern equipment can be introduced. It is even more necessary that such progress should not involve hardship to the human element.

Industrialism in England moves on apace and the town continues to swallow up the countryside. This is a healthy economic sign even though it leads to unhealthy social conditions. The old order of towns and villages is giving place to new groups of towns or 'conurbations' and regional associations. Mr. F. Longstreth Thompson in his address on 'Recent Developments in Town Planning,' read at the Surveyors' Institution on Mar. 4, enumerates no fewer than 67 joint committees covering a total area of almost 12,000,000 acres and having a population of approximately 30,000,000—out of a total population for England and Wales of only 38,000,000. In view of the near approach of the next census, this raises a question of great importance. Hitherto the statistical information has been given separately for the towns, the urban and the rural districts. This assumes an economic isolation which no longer exists, and serious consideration should be given to furnishing returns on the basis of these new divisions which have developed by and from the recognition of mutual dependence and interests. For the sake of continuity it may be essential to maintain the earlier census divisions, but supplementary summaries may at least be possible.

Returning to Mr. Thompson's paper, he points out two useful outgrowths from the original Town Planning Act. For the moment, town-planning schemes are confined to land which is in course of development or appears likely to be used for building purposes. For boroughs and urban districts with a population

of more than 20,000, such schemes are obligatory, though the date of their completion has been twice postponed. The fact that other communities have organised themselves voluntarily for the preparation of a scheme shows that regional and town planning is now accepted as part of local administration. The latest developments have been in the direction of controlling areas already built upon. The Minister of Health now has powers to act with the view of preserving the existing character and protecting the existing features of any locality of special architectural, historic, or artistic interest. Advantage has already been taken of this permission to prepare schemes for Oxford, Winchester, Exeter, and Canterbury. Mr. Thompson notes also that official consideration is being given to the question of extending town-planning powers in respect of all built-on areas and that it may be anticipated that the scope of the Act will be enlarged in this sense in the not distant future.

At the time of writing no detailed account has appeared of the circumstances attending the commencement of the disastrous floods that began on Mar. 13 in Alabama, U.S.A., owing doubtless to the speedy interruption of communications between the devastated area and the outside world. In the *Weekly Weather and Crop Bulletin* of the U.S.A. Department of Agriculture, it is stated that in January a large part of the States northwards and northwestwards from the Ohio and Missouri valleys had extreme cold, with heavy snowfall, which in some places exceeded anything known before in January. The rainfall over Alabama for that month was, however, not remarkable. In February there was an equally pronounced area of cold, rather farther south than that of January; the distribution of excessive precipitation was different and covered a smaller proportion of the country, Alabama lying, however, well within the most notable wet region, which included the Atlantic coastal States and extended south-westwards to the Lower Mississippi River. Within this wet zone the fall was sometimes more than twice the normal for the month. The same publication contains a note of excessively heavy rains over parts of Alabama early in the present month, and of the rivers Tombigbee and Coosa being in flood before the end of the first week.

More recent meteorological information is available on the charts for the northern hemisphere published by the Meteorological Office, London. Between Mar. 10 and 12, a large anticyclone moved eastwards from a position south of the Great Lakes. A long chain of depressions which extended from Alaska southwards to the western part of the Gulf of Mexico, if not still farther, began to replace the anticyclone and brought wet weather with southerly winds and rising temperatures to the Gulf States. Cyclonic weather appears to have continued at least up to Mar. 16, that is to say, for three days beyond the date when the floods are reported to have begun. The southerly winds evidently extended from regions well within the tropics, and must have been heavily charged with moisture. It is reasonable to suppose that the work of the tropical rainstorms may have been aided by rapid melting of the snow on high ground farther north, and that the overcharged rivers burst their banks or 'levees,' as happened in the Mississippi floods of 1926–27. Such disasters, and the more frequent devastations on a smaller scale due to travelling 'tornadoes,' are inevitable in a country where the gradient of temperature with latitude in early spring is so steep. It is the presence of the tempering waters of the North Atlantic in high latitudes that saves the British Isles from like visitations.

Several of the Livery Companies of the City of London have made very substantial provision for the development of science and technical education; and it is estimated that the amount actually expended by them on these objects exceeds two million pounds. Some of the companies have established scholarships or fellowships, in addition to making grants to institutions. Thus, the Grocers' Company has three scholarships of £300 a year each, for inquiry into causation of prevalent disease or as to means of prevention of premature death; the Salters' Company has founded its Institute of Industrial Chemistry, which offers fellowships of £250 to £300 a year to chemists of graduate standing to enable them to undergo a special further training for careers in chemical industry; the Drapers' Company has devoted £20,000 to scholarships for the textile industries; and similar endowments have been made by the Leathersellers' Company and the Fishmongers' Company. About six years ago the Armourers' and Brasiers' Company founded its research fellowship in metallurgy, which is awarded by a committee consisting of three persons appointed by the Company and four appointed by the Royal Society, and is of the value of £500 a year. Miss C. F. Elam has done very successful research in metallurgy while holding this fellowship for the past five years, and she still has another six months in which to continue her work. Announcement is now made that a new fellow will shortly be appointed. Full particulars of the fellowship can be obtained on application to the Secretaries of the Royal Society, Burlington House, London, W.1.

Widespread interest has been aroused by the announcement made by Mr. Leonard C. Woolley in the *Times* of Mar. 16 that he has discovered at Ur evidence for the historicity of the Flood of Genesis and Mesopotamian legend. In excavating the deposits belonging to the early occupation, to which reference has been made in previous communications, he found relics of human activity on the low-lying parts of the island which had been submerged under a huge bank of water-laid clay of some eight feet in thickness. On top of this was a fresh occupation which carried on some of the old traditions but departed entirely from others. There is thus a break in continuity caused by this disaster which he suggests can be none other than the flood of Sumerian history and legend.

Comments by Sir E. A. Wallis Budge and others appear in the *Times* of Mar. 18, and they generally

accept Mr. Woolley's suggestion. The most interesting comment is that made by Prof. S. Langdon of Oxford, who has revealed some hitherto unpublished evidence from the expedition at Kish which conclusively points to the historical nature of the Bible story. At Kish, where excavations have been carried down to virgin soil, are two precipitations of clay containing potsherds and stranded fish lying perfectly horizontal in a way which could only be the result of a flood. This flood took place between 3400 B.C. and 3200 B.C. Another deposit of a similar character on the water level is dated at about 4000 B.C. Prof. Langdon is inclined to regard the flood of Genesis as the one between 3400 B.C. and 3200 B.C., which he connects with the Sumerian legend of Ziudzudra, the last of the antediluvian kings in the traditional royal lists, who built a boat to escape the waters. This legend was incorporated in Babylonian story and thence reached the Hebrews. In view of the extreme interest of this theory, it is scarcely necessary to stress the importance of securing continuity of excavation at both Ur and Kish. We hope that public interest may be stimulated by this latest discovery to provide the necessary funds.

IT is now more than six years since the inauguration of broadcasting produced a world-wide demand for a loud speaker. A paper by R. P. G. Denman on the development of these instruments was read to the Royal Society of Arts on Mar. 13. The early forms of loud speakers were incapable of radiating sound the frequency of which was below about middle C (256). This was not at first recognised, as the ear has a marvellous power of reconstructing a mutilated complex tone. A pure tone is essentially a single vibration which follows the sine law. In a complex tone we have one or more overtones in addition. The B.B.C. recently carried out experiments to determine the minimum value of the amplitude of the second harmonic which must be superposed on the first harmonic so that it becomes noticeable in an ordinary loud speaker.

IT was found in the B.B.C. experiments that when the frequency of the fundamental was 900, the amplitude of the second harmonic has to be at least 3 per cent. of the amplitude of the fundamental before it becomes audible. At higher frequencies a much greater percentage is necessary. When the frequency, for example, is 5000, the percentage of the amplitude of the second harmonic required for audibility is 49. The introduction of cone loud speakers and the annulment of resonance effects by frequency filters were notable steps in advance. The efficiency of transformation of all ordinary loud speakers is very low. Some of the loud speakers, however, used in the commercial operation of 'Movietone' and 'Vitaphone' talking-film systems have efficiencies of 30 per cent. A new Western Electric loud speaker is claimed to have a fifty per cent efficiency. It seems probable that great improvements will be made in the near future in the instruments used in theatres, and that the small domestic loud speaker will either remain as it is or become similar to a small auditorium instrument.

AT a meeting of the Section of Neurology of the Royal Society of Medicine, held on Mar. 14, a kinematograph demonstration was given of a film, showing some of the experiments on conditioned reflexes done in Prof. Pavlov's laboratory at Leningrad. Although the work and conclusions were familiar to most of the audience, yet it was obvious that the film proved interesting, giving, as it did, a reality to experiments hitherto known only through verbal descriptions in text-books. The film is not intended for the general public, but as a means of illustrating lectures for students; as such it certainly seems to have many advantages. There is, however, a possibility of danger, for it would be very easy to select a series of experiments because they happen to illustrate a thesis and to omit the negative instances; the arresting nature of the presentations renders this more serious than in any other form of exposition. There can be no question as to the scientific value of Prof. Pavlov's experiments, but the deduction therefrom that man is nothing but a bundle of conditioned reflexes is fallacious. The Society is to be congratulated on the novel and provocative form of meeting.

THE controversy about the future development of the Bodleian Library has been closed by the acceptance of a decree in Congregation authorising the University Chest to receive subscriptions for the carrying out of a definite scheme of extension. The scheme is of the nature of a compromise, and is probably not thoroughly satisfactory to any of the interested parties. It involves the transformation of part of the north side of Broad Street, one of the characteristic features of Oxford, and also the removal of some of the Bodleian stores to a site three miles distant from the city. A recent decision of the Curators to exclude certain kinds of literature, considered to be of merely ephemeral value, gives rise to some difference of opinion, many people holding that publications of this kind may become, with the lapse of years, of great interest and importance as illustrating manners and modes of life of the present day.

THE Zoological Society of London celebrates this year the centenary of the granting of its Royal Charter in 1829, three years after the formation of the Society itself, and an announcement has just been made of the manner in which the occasion is to be commemorated. The large number of fellows, of whom there are now more than 8000, has made necessary the arranging of more than one function. A centenary celebration meeting will be held in the Great Hall, University College, Gower Street, on April 29, when centenary speeches will be delivered and official and foreign guests will be present. In the evening of the same day the foreign and official guests will be entertained to dinner by past and present members of council and other officials of the Society. The greatest gathering of all will be a centenary celebration garden party, to be held at the Society's Gardens on the evening of June 20, and to this every fellow will receive an invitation for himself or herself and one guest. In an earlier note we referred to the historical account of the development of the Society to be written by Dr. P.

Chalmers Mitchell, and we understand that this interesting volume is well advanced.

As recently announced by the Prime Minister of the Commonwealth of Australia, the Commonwealth Government is promoting an expedition, under the leadership of Sir Douglas Mawson, for scientific and survey work in the Antarctic lands lying south of Australia. The British Government is making a financial contribution sufficient to enable the R.R.S. *Discovery* to be placed at the disposal of the Expedition. It is anticipated that the investigations will occupy two seasons, from the summer of 1929 to the summer of 1931. Every effort will be made to maintain the closest co-operation between the Australian work and that already in progress under the *Discovery* Committee, and in order to assist in securing complete uniformity of method a member of the *Discovery* staff will be seconded for service with the Australian Expedition. In view of the loan of the *Discovery* to the Australian Expedition, the Secretary of State for the Colonies has sanctioned the construction of a ship which, with the *William Scoresby*, will enable the work of the *Discovery* Committee to be continued. The new vessel will be a steamship with a superior radius of action, and will be able to undertake long ocean traverses for which the *Discovery* is not well suited. She will carry echo-sounding gear and also a specially designed winch, carrying 5000 fathoms of wire rope, for working large nets at any depth. For smaller nets and hydrological observations three auxiliary machines will be provided. Large biological and chemical laboratories on the upper deck, a photographic room and a survey office, workshop storerooms and other accommodation necessary for the intended service are being provided. In addition to a full complement of executive officers, she will carry a scientific staff of six and a survey officer, the total of officers and crew being about fifty. The vessel is being constructed at Port-Glasgow by Messrs. Ferguson Bros. (Port-Glasgow), Ltd.

ON Tuesday, Mar. 12, Dr. H. Przibram, professor of experimental zoology in the University of Vienna, delivered, at the request of Prof. E. W. MacBride, a lecture on the "Transmission of Acquired Modifications from Parent to Offspring" in the Imperial College of Science. Dr. Przibram commenced by referring to the four postulates in Weismann's theory of natural selection, and stated that every one of the four has proved to be untrue. He also referred to theories of Mendelian inheritance, depending upon 'genes,' which would require modification in the event of the discovery that acquired modification could be transmitted to offspring. Dr. Przibram pointed out that although no one sufficiently skilled to be able to repeat the work of his pupil, Kammerer, on rearing Amphibia for several generations had yet appeared, Kammerer's results, so far as the effects of the environment on one generation are concerned, had received abundant confirmation in recent years, the latest of these being the discovery in the Jardin des Plantes in Paris of a strain of *Alytes* which bred in or near the water, in which the males had vestigial 'nuptial pads' on their hands.

DR. PRZIBRAM described a long list of experiments made in recent years which had given evidence of the transmission of acquired characters. Many of these have been performed in his own laboratories under his supervision, and incidentally he remarked that the fact that some people had tried to repeat them and failed was no disproof of their validity, for in experiments of this kind where conditions are complicated, the failure to get one condition out of the whole number right was sufficient to upset the experiment. Perhaps the most interesting part of the lecture was that in which Dr. Przibram outlined his attempt to analyse how environmental effects are transmitted to offspring; thus rats brought up in high temperatures have longer tails than those bred at low temperatures, but the heat of the air does not act directly on the growth of the tail, but indirectly, by stimulating metabolism and increasing body temperature. One is involuntarily reminded of that far-seeing dictum of Lamarck's: "But what ever it does, the environment never directly affects the growth of an animal, but indirectly by altering its needs necessitating fresh efforts on the part of the animal to satisfy them, causes it to use some parts more than others and so stimulates their growth."

IN the course of an address on "Road Transport," read before the Junior Institution of Engineers on Mar. 8, Mr. S. H. Hole stated that the first practical mechanically propelled road vehicle was the steam tractor built by Cugnot in 1769, which carried four persons and attained a speed of $2\frac{1}{4}$ miles per hour; an improved type was designed to carry $4\frac{1}{2}$ tons at the speed mentioned, and cost £800. In 1798, Trevithick and Vivian patented inventions relating to high pressure steam in connexion with locomotion, and in 1803 had a road vehicle in operation in the streets of London. Between 1827 and 1830, steam coaches were in operation between Gloucester and Cheltenham which had an average speed of 12 miles per hour with a maximum of 20, and they were operated successfully in London until Parliament enforced tolls in the proportion of 12 to 1 as compared with the four-horse coach, and they thus fell into disuse. A still further check to the progress of mechanical transport was the Act passed in 1865, limiting the speed of mechanically propelled vehicles in the country to 4 miles and in towns to 2 miles per hour, with a flagman in front. The years 1906 and 1907 saw important changes in motor-car design, when magnetos replaced coil and battery ignition and the worm drive to the live back axle, coupled with a differential gear, was built by Lanchester. The more rapid development in mechanical transport, both for goods and transport, during the past twenty years, has been due largely to research on the properties of special steels; this has enabled great reductions in weight to be made without sacrifice of reliability. The progress in machine tools and in the scientific balancing of engines, especially for aeroplane purposes, have all aided the evolution of the modern car. Further lines of progress will be in the number and positioning of cylinders, higher speeds of engines, combined with decreased weight and greater flexibility.

THE dramatic element in aerial flight has always appealed to the popular press and would have succeeded in maintaining a live interest in that subject whether the technical men were active in it or not, but the scientific interest has been steadily pursued, and the time is rapidly approaching when special journals will require to be produced to cater particularly for this development. Germany has already a number of journals of this type. In Great Britain we have been very prone in the past to maintain our scientific journals in omnibus type, and only workers in such specialised fields realise the difficulties involved in digging out and collecting the papers they are concerned with from these various miscellaneous journals; our scientific press is certainly not scientifically organised. On the aeronautical side, the reports of the Aeronautical Research Committee have in this respect pursued a very effective policy, but they suffer from two disadvantages. They are in the first place almost entirely confined in their publications to the work which is being undertaken in Government research establishments: in the second place, they are issued to the public almost a year after the work has been executed. Scientific workers, therefore, not professionally in immediate contact with these places, but striving to work in these fields, must continually lag behind in respect to any developments that have occurred. No doubt there are difficulties in the way of earlier issue to the public. A new journal, styled *Aircraft Engineering*, under the able editorship of Lieut.-Col. W. Lockwood Marsh, has now made its appearance—an old title for a new paper. In format it is not unlike *Engineering* itself, but it is a monthly journal and restricts its attention to those matters of direct interest in the design and construction of aircraft and in research work on aerodynamics. It is intended to be a scientific and technical journal for aeronautical engineers and research workers. The first issue in March contains, among other important articles, a résumé of the research and technical progress in 1928, special discussions on stream lining of air-cooled engines, on a new theory of tail flutter, and on the efficiency of the auto-gyro. If the standard of succeeding issues can be maintained, this journal should play a very important part in the concentration of aeronautical publication.

ACCORDING to the annual report of the U.S. Bureau of Standards for the year ending June 1928 (Washington, D.C.: Government Printing Office, 5 cents) the work of the Bureau has been divided into two groups, the first dealing with scientific research and testing, the maintenance of standards and their improvement, the second with the supervision of commercial standards with special reference to the needs of industry. The regular staff now numbers 860, and the salaries 572 thousand dollars per annum. The fee values of the tests carried out by the Bureau were: for the public, 67 thousand dollars; for the Government and States, 351 thousand dollars; and for the Bureau, exclusive of research and standardisation tests, 46 thousand dollars. Upkeep of the buildings, plant and grounds has cost 83 thousand dollars and additions 88 thousand dollars. The work done is summarised under various headings, the total cost of each group is stated, and ten or a dozen lines are devoted to a description of each research of the group.

IN order to test structural and miscellaneous materials, the Bureau of Standards maintains three branch laboratories, one at Northampton, Pa., one at Denver, Col., and one at San Francisco. These branch laboratories are fully occupied, and there is need for increase of personnel and equipment to cope with the ever-growing increase in the work. In view of the hazardous tests sometimes carried out at the Bureau, a demand is made for a first-aid station under the care of a competent physician. Elaborate apparatus has been constructed in order to obtain a more accurate value of the constant of gravitation, as a knowledge of this constant is necessary in many tests. The tests made with metal furniture prove that the fire risk is considerably diminished by its use. Metal shelving in particular prevents a fire from spreading. The large variation in the index of refraction of lead glass with the annealing temperature has been investigated. Good practical work has been done in developing radiobeacons for aeroplanes. A demonstration between two air ports was given of a new type of beacon which produces visual signals on an instrument on the aeroplane board. Aeroplanes fitted with these instruments can fly perfectly safely in fog or darkness between these ports although no landmarks are visible.

THE Council of the Royal Society of Edinburgh has awarded the Gunning Victoria Jubilee Prize for the period 1924–28 to Prof. Edmund Taylor Whittaker, in recognition of his distinguished contributions to mathematical science, and of his promotion of mathematical research in Scotland; and the Makdougall-Brisbane Prize for the period 1924–28 to Dr. W. Ogilvy Kermack, for his contributions to chemistry, published in the Society's *Proceedings* and elsewhere.

THE Council of the Iron and Steel Institute has this year decided to present its Carnegie Gold Medal to Dr. Arthur Bramley, head of the Metallurgical Department of the Loughborough College. The Medal, which was founded by the late Mr. Andrew Carnegie, is awarded to the research worker who, in the opinion of the Council, has produced the most meritorious piece of research work in each year under the scheme of the Andrew Carnegie Research Scholarships of the Institute.

AT the invitation of the Société Française des Électriciens, the summer meeting of the Institution of Electrical Engineers will be held in France on June 11–22. The Paris-Orléans and Midi Railways are providing railway transport free of charge for a trip to the Pyrenees, and the Chemin de Fer du Nord will transport the party between Calais (or Boulogne) and Paris at half-fare. Numerous visits to works and places of interest are being arranged.

A PUBLIC meeting on Developments of British Chemical Manufactures has been arranged by the British Science Guild and will be held in the Mansion House, E.C.2, on Wednesday, April 24, at 4.30 P.M., when the Rt. Hon. Lord Melchett, president of the

Guild, will take the chair. The programme will include the following addresses: (1) "Fertilisers from the Air," by Sir Frederick Keeble; (2) "Rayon (Artificial Silk)," by A. B. Shearer; and (3) "Synthetic Drugs," by F. H. Carr. Tickets for the meeting may be obtained on application to the British Science Guild, 6 John Street, Adelphi, W.C.2.

A SEVERE earthquake occurred in the North Atlantic on Feb. 22 at 3.41 P.M. The position of the epicentre is given by the seismologists of the U.S. Coast and Geodetic Survey as approximately in lat. 10° N., long. 42° W., or about a thousand miles from the mouth of the river Amazon (*Daily Science News Bulletin*, Science Service, Washington, D.C.). This region is one of the belts of seismic activity in the Atlantic Ocean and was the scene of a severe earthquake in October 1925, recorded by instruments all over the world. As it also lies along the course of vessels between New York and Pernambuco, the shock must have been felt on any passing ships as if the vessels were grating on the ground below.

A NEW part (No. 813) of Sotheran's invaluable "Catalogue of Science and Technology" has reached us. Its designation is Part IX.: XIII. Engineering, Section 1, and gives the titles of and much bibliographic information respecting periodical publications, early works to the end of the eighteenth century, and general works, including lives of engineers. The list can be had upon application to the publishers, 140 Strand W.C.2.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Temporary assistants and temporary sub-assistants in the Herbarium of the Royal Botanic Gardens, Kew—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (April 8). A sub-inspector of quarries in the Midland and Southern Division of the Mines Inspectorate—The Under-Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, Millbank, S.W.1. (April 20). A secretary of the Institute of Physics and editor of the *Journal of Scientific Instruments*—The President, Institute of Physics, 1 Lowther Gardens, S.W.7 (April 21). A director of extra-mural studies in the University of Birmingham—The Registrar, The University, Birmingham (April 27). A clinical pathologist at the Crichton Royal Mental Hospital—The Physician Superintendent, Crichton Royal Mental Hospital, Dumfries. A clinical bacteriologist at the Cheshire Joint Sanatorium, Market Drayton—The Medical Superintendent, Cheshire Joint Sanatorium, Market Drayton. A male junior assistant under the Directorate of Ballistics Research, Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich.

Our Astronomical Column.

A PROBABLE NEW TROJAN PLANET.—The Trojans are a group of minor planets the period of revolution of which is the same as that of Jupiter, and which maintain an approximately constant position relatively to Jupiter; four of them, Achilles, Hector, Nestor, Agamemnon, are 60° in front of Jupiter, while Patroclus and Priamus are 60° behind it. *Beobachtungs-Zirkular* No. 7 states that Nestor was photographed by Dr. Reinmuth at Königstuhl on Feb. 9; on the same plate, 46′ east of Nestor and 36′ north of it, another planet was found with the same motion as Nestor in Right Ascension (− 0·5 m. daily). This is much slower than the average retrogradation of the asteroids when near opposition, and makes it probable that the new body belongs to the Trojan group. Its provisional designation is 1929 CM. It is slightly brighter than Nestor, their magnitudes being 14·2 and 14·8 respectively. 31 new planets were discovered in the first half of February.

THE SPECTRA OF COMETS.—The theory of Schwarzschild and Kron on the nature of comets' tails is extended by H. Zanstra in the *Monthly Notices* of the Royal Astronomical Society, vol. 89, p. 178, to explain the line and band spectra of the heads. It is suggested that the observed lines are resonance lines producible under low excitation, or in some special instances are caused by fluorescence; in other words, sunlight is absorbed by the gases of the comet's head and then re-emitted in the same (or sometimes longer) wave-length. The intensity of the spectrum to be expected from this theory is computed and compared so far as possible with actual observations. The result seems to show that the theory is quite sufficient to account for the observed luminosity in the case of such comets as are considered, though some of the very bright comets with only one known apparition may provide a severer test. One example of such comets (Comet Wells, 1882) is discussed in some detail. The *D*-lines of sodium were observed to be very nebulous, which is in agreement with the requirements of the theory, while the iron lines noticed in this comet are capable of explanation by fluorescence.

THE UNIVERSITY OBSERVATORY, OXFORD.—The report of this Observatory for 1928 has been issued. It records the completion of the measurement of the plates taken at the Vatican Observatory for the Astrographic Catalogue, and sent to Oxford for measurement; the Pope has presented medals to the director and his assistants in recognition of their share in this work. The zeal of the director, Prof. H. H. Turner, for the completion of the whole Catalogue is well known. He has undertaken to complete the southern portion (+ 32° and + 33°) of the zone originally allotted to Potsdam. The northern portion is being undertaken at Hyderabad, and it is hoped that the middle may be filled in by an observatory in the United States.

Allusion is made in the report to Dr. Fotheringham's work on the Venus tablets of Ammizaduga, in conjunction with Prof. Langdon, and to his studies on the relation between Babylonian and Greek astronomy, with special reference to Naburianos and Cidenas.

The new buildings in the Observatory have been completed. The seismographs have been moved there from the Clarendon Laboratory. The upper rooms afford a much-needed extension to the Library. Five papers and reports on seismology by the Director have been published since the last annual report. The cœlostat belonging to the Observatory has been lent for the expedition to Siam to observe the total solar eclipse of May 9.

Research Items.

Neolithic Fayum Pottery.—In *Ancient Egypt*, 1928, pt. 3, Miss G. Caton-Thompson has released in advance an account of the neolithic pottery of the Fayum, pending adequate publication of the material collected in the three seasons' investigations, of 1924–1925, 1925–26, and 1927–28. The bulk of the material is from a larger midden settlement, Kom W, of more than 600 ft. by 400 ft. and about 5 ft. deep. It belongs almost entirely to the earlier Neolithic or Fayum A period. Other and better-preserved vessels came from straw-lined granaries. Some were found singly in other parts of the desert. All the pottery is handmade in coarse clay with straw as a *degraissant.* Unequal and insufficient firing has produced a grey mottling on red pots, the core in nearly all cases being black and soft. Owing to the combination of organic matter from the midden and the salt of the desert, the texture has suffered and few pots retain their original surface. Many of the pots were rough-faced and devoid of slip and burnish. Some may originally have had a slip. A polished ferruginous wash and a burnished black finish were frequently used. One class (class 5) is associated with a thin ferruginous slip, polished and of a purple-red colour similar to the old Nile Valley pre-dynastic wares. Black polish is rare. A few sherds were hand smoothed. The forms are grouped into five classes: (1) Small bowls and cups; (2) cooking bowls or pots—these two classes being of the type common to all primitive ceramic development; (3) pedestal cups, an important class suggesting the prototype of rare and early Nile Valley pre-dynastic vases—this form occurs in the Middle Neolithic stratum at Knossos; (4) cups, with legged bases—poorly represented; (5) rectangular dishes with 'peaked' rims—a type which appears to have no parallel in the pre-dynastic period.

Milk Yield of Dairy Cows.—A statistical analysis of the data of the Scottish Milk Records Association by Dr. J. F. Tocher has been issued by the Biometric Laboratory, University College, London (*Biometrika*, vol. 20, B, pt. 2, p. 105; 1928). There is a distinct improvement in the milk yields of recent years compared with those of twenty years ago, from an average of 16½ gallons to one of 18½ gallons per week. The yield per week is shown to vary with age of cow. Young cows give an average of less than 16 gallons, whereas cows of 9-11 years give more than 20 gallons. There has also been an average increase in total butter fat, amounting to 7 per cent. The monograph is profusely illustrated with diagrams and photographs, and contains a number of tables, some of which should be of value to the practical dairy farmer. For example, there are tables showing the yield of milk for each stage of lactation period, and one showing the average amount of butter fat obtained for cows of a given age and for a given length of lactation period. A farmer could thus compare the actual yield of a cow with the average, and so determine whether she is up to standard.

Control of Powder-post Beetles.—Beetles of the genus *Lyctus* are commonly termed 'powder-post beetles' from the fact that their larvæ bore into timber and, as a result, give rise to the production of a fine powdery dust or 'frass.' Particular attention has been paid to these insects at the Forest Products Laboratory at Princes Risborough, and the result of recent inquiries are embodied in *Bulletin* No. 2 (1928), Forest Products Research, by Dr. R. C. Fisher. Evidence has been collected which indicates that the increase and spread of these insects in Great Britain since the War have been due to the importation of infested American ash and oak. Among the most notable facts stressed in this *Bulletin* is the egg-laying habits of these beetles. In the species studied the eggs are always inserted within the vessels or pores of the wood, whether they be transversely or horizontally exposed, and are never laid on the surface. It is therefore impossible to see a *Lyctus* egg except by microscopical examination of the wood. A definite correlation has been found between *Lyctus* attack and the size of the vessels in different kinds of wood. So far as is known, the insects never attack conifers, probably owing to the absence of vessels or pores in which their eggs could be placed. Not all hard woods are attacked, and those with large vessels are the most liable to suffer: such close-grained timbers as beech and birch have not been observed to be attacked, and it is very probable that the size of their vessels is too small to allow of the insertion of a *Lyctus* egg. In so far as control measures are concerned, the Laboratory has concentrated its attention upon the practicability of heat sterilisation of infested timbers before practical utilisation. Humidity is an important factor to be taken into account, and there is evidence that prolonged treatment with humidity between 60 per cent and 70 per cent, provided the temperature does not fall below 120° F., would probably suffice for the purpose. The *Bulletin* may be obtained, price 3*s*. net, from H.M. Stationery Office or through any bookseller.

Thoracic Appendages of *Anopheles* Larvæ.—The existence of peculiar paired dorso-lateral organs on the anterior region of the thorax of *Anopheles* larvæ was described by Nuttall and Shipley in 1901, and confirmed by Imms six years later. On account of their transparency these structures are not easily seen, and this probably explains why they have been almost entirely overlooked by subsequent investigators. Mr. M. O. T. Iyengar, in the *Indian Journal of Medical Research*, vol. 16, No. 2, 1928, has studied these organs in 29 species of *Anopheles* besides examining many Culicine larvæ, but in the latter creatures the thoracic appendages were entirely wanting. Each appendage is capable of contraction and extension, and is moved by a special muscle. Morphologically the organ consists of a basal pedicle and two apical lobes, each of which is provided with a flat cuticular expansion. It is believed that the thoracic appendages, by maintaining close contact with the surface film, act as anchoring organs which maintain the larva in a constant position, and enable it to withstand the forward 'creep' while working its mouth-brushes and thus setting up a current in the water. In the case of a Culicine larva, the movements of the mouth-brushes causes the animal to move in a forward direction all the time it is feeding.

New Bivalves from South America. In a paper entitled "New Freshwater and Marine Bivalve Shells from Brazil and Uruguay" (No. 2762, *Proceedings of the United States National Museum*, vol. 74, art. 17), Mr. William B. Marshall, assistant curator, Division of Mollusks, United States National Museum, describes a new pearly freshwater mussel from Brazil, four new freshwater mussels and three marine bivalves from Uruguay. *Diplodon Jacksoni* n. sp. is a handsome shell collected by Mr. Ralph W. Jackson of Cambridge, Md., from Areas, Province of Mines, Geraes, Brazil. Its beak sculpture is usually well preserved and the whole shell measures 49 mm. by 28 mm. (type specimen). It is closely related to *Diplodon santamariæ*. The mussels from Uruguay are a Diplodon, two Anodonites and a Mycetopoda.

A Corbula and two Nuculas from Uruguay are also described. One of the Nuculas, *Nucula Felipponei*, called after the donor, was taken from the stomach of a fish known as a corbina, *Micropogon undulatus*. Photographic plates are given of all these new species.

THE CULT OF THE PRIMULA.—The first hundred pages of the *Journal of the Royal Horticultural Society*, vol. 54, part 1, 1929, are taken up with the report of the proceedings of the fourth Primula Conference, held under the auspices of the Society on Thursday, May 24, 1928, during the Chelsea Show. The greater part of the space is occupied by the important paper by Prof. W. Wright Smith of Edinburgh and Mr. G. Forrest upon "The Sections of the Genus *Primula*." This paper has previously been published in the *Notes from the Royal Botanic Garden*, Edinburgh, No. 76, March 1928. Accompanying this paper in its present, somewhat altered, form are a large number of beautiful photographic illustrations of various species of *Primula*. Similar photographs accompany many of the other papers, which include some interesting notes on the Primulas of the Far East, especially a valuable discussion of their natural habitats in the East, by Dr. W. Handel-Mazzetti, of the Natural History Museum, Vienna. There are also valuable notes on cultural experience with difficult and rare species, whilst the workers at the John Innes Horticultural Institute are responsible for some interesting communications upon genetic experiments with *Primula*. The late Dr. Bateson commenced experiments upon the genetics of *P. sinensis* so far back as 1903; these were continued by Mr. Gregory and had yielded many valuable results before they were cut short by his untimely death in 1918. The three papers in the *Journal* upon *P. sinensis*, *P. Kewensis*, and *P. Juliæ* and its hybrids with the oxlip and primrose, are brief and clear summaries of the present state of our knowledge of the genetics of these species.

JOLY'S THEORY OF THERMAL CYCLES.—In a recent number of *Gerlands Beiträge z. Geophysik* (vol. 20, p. 288; 1928), Prof. J. Joly replies to criticism by Dr. F. Lotze. He points out that the theory of thermal cycles is more in keeping with the complexity of the earth's surface history than one of uniform loss of heat. The suggestion of Dr. J. W. Evans that radioactive energy may be in large part expended on chemical changes within the rocks dies hard. Joly again directs attention to the fact that this suggestion is in flat contradiction with all investigations bearing on the subject. He further claims, in opposition to Lotze, that volcanic heat liberated at the surface is negligible in quantity, and that it cannot be supposed to proceed in its entirety from the deep-lying substratum which is responsible for the cycles. Perhaps the most interesting feature of this short paper is the tacit abandonment by Joly of the 'short' estimates of geological time, of which in recent years he has been by far the most ardent advocate. On p. 289 he asks, "To what other source than the theory of thermal cycles can we refer the repetitional character of earth-history covering much more than a thousand million years?" Later, he states that "the surface history of the earth must have already run some thousand millions of years when the Appalachian Revolution took place." The momentum of the older view favouring a hundred-million-year earth may now be said to have spent itself, leaving a clear field for the development of a geological time scale based on radioactive disintegration.

DOMESTIC GRATES AND COKE.—In a lecture delivered on Jan. 16 and printed in the *Journal of the Royal Society of Arts* for Feb. 15, Prof. C. R. Darling put before the Society what he considers a practical solution of the domestic smoke problem. He has used, for two years, a grate for burning gas coke, in which the difficulty of ignition has been met by the incorporation of a gas burner. This grate, introduced by the South Metropolitan Gas Company, seems satisfactory and economical, so that, taken in conjunction with other appliances and smokeless fuels available, Prof. Darling considers that there is no technical obstacle to a large immediate reduction of domestic smoke. This would follow the replacement of raw coal by gas coke and anthracite where possible, and so far as available. Meanwhile the development of low temperature carbonisation processes will result in additional supplies of smokeless fuels to supplement the coke by the time demand for coke overtakes supply. Technically, Prof. Darling's claims are well founded. The room-heating efficiency of gas coke consumed in an open grate is greater than that of coal and at least as great as that of low temperature cokes. The grate, however, must be accommodating to the peculiarities of coke, but the monetary saving following the use of coke will easily pay the cost of adaptation. Unfortunately, in the matter of home-heating, custom, prejudice, and æsthetic considerations often determine the choice, not technical efficiency. Moreover, until the ash content is brought much nearer to what is customary in house coal, it will be hard to secure the general adoption of coke in the open domestic fire.

EFFECT OF ANTI-KNOCK MATERIALS ON FLAME SPEED.—The *Proceedings of the Imperial Academy of Science*, Tokyo, vol. 4, No. 9, contains a paper by Y. Nagai on the speed of the initial uniform movement of the flame in hydrocarbon–air mixtures. The effect of the addition of up to 25 per cent of diethyl selenide, tetramethyl tin, and tetramethyl lead to such mixtures was investigated in a long glass tube. The flame speed, which was measured photographically, decreased with the concentration of the anti-knock agent up to a certain point. This effect is explained by a consideration of the differences between the theoretical propagation temperatures of the hydrocarbon (1450°) and diethyl selenide (1750°) and the tetramethyl compounds (both 1680°). It is suggested that the theoretical flame propagation temperature of the hydrocarbon is raised by addition of the anti-knock compound until it reaches the corresponding temperature for that compound. The maximum anti-knock effect is then obtained.

AMATEUR KINEMATOGRAPHY.—Dr. C. E. K. Mees has contributed an article to the January issue of the *Journal of the Franklin Institute* which includes an account of the Eastman Kodak Company's new Kodacolor process, which has been specially designed for the production of coloured films by amateurs. In this, a colour filter with three separate areas—red, green, and blue—is used over the surface of the camera lens, and the film surface, instead of being flat, is embossed with small cylindrical lenses of the film material by forming it through steel rollers. These lenses intercept the light directed on to the sensitive emulsion, which is at the back of the film, and so impress upon the latter three distinct sets of images, one for each of the primary colours of the filter. The film is developed by a reversal process, and projected through an optical system which is essentially the same as that used for its production, the triple filter appropriate to the colour sensitivity of the emulsion being again placed over the lens. A drawback of this method appears to be that there is considerable absorption of light by the colour filter used in projection,

with the result that only small pictures can be thrown on to the screen, but Dr. Mees states that although the Kodacolor process has been on the market for only a short time, the results that are being obtained show quite definitely that it is successful, and that with reasonable care there is no more difficulty now in obtaining motion pictures in colour than in the making of still photographs.

COSMIC RAYS.—The papers on cosmic rays that have appeared in Continental journals during the last three years have not hitherto led to any new results which have been generally accepted, and have not attracted much attention. Most of them have, however, included detailed reports of the observations which have been made, and have thus furnished a valuable collection of data for a statistical investigation, which has now been performed by A. Corlin, of Lund Astronomical Observatory, and published in the form of a *Communication* (No. 115) from this observatory in the *Zeitschrift für Physik* (vol. 50, p. 808). His analysis has brought to light a consistent variation in the intensity of the softer components of the radiation during the sidereal day. A maximum occurs at about 15 h., a minimum at about 11 h., and a second, but less definite maximum, at about 7 h. The finer details of the intensity–time curves of different investigators also show a certain degree of similarity. If soft rays are screened off from the ionisation chamber, temporal fluctuations are not present. The obvious inference is that the more penetrating cosmic rays are produced indifferently throughout space, but that at least a part of the softer radiation has a more localised origin. In a second *Communication* (No. 116), which has been published in the *Arkiv for Matematik, Astronomi och Fysik* (vol. 21, No. 1), it is suggested that the softer rays are really initially hard, but that they are produced inside material celestial bodies, and are softened by scattering on the way out. Further investigations are evidently needed to settle the important points that have been raised in these two papers, and, as is pointed out, it would be extremely valuable if it could be arranged that simultaneous records of the ionisation produced by the cosmic rays were made at different latitudes.

THE PREVENTION OF IONISATION IN PAPER DIELECTRICS.—Messrs. S. G. Brown and P. A. Sporing read a paper on the prevention of ionisation in paper dielectrics to the Institution of Electrical Engineers on Mar. 14. It is known that the performance of paper-dielectric condensers, which are much used in Great Britain in connexion with 600 volt alternating current systems, has not been satisfactory. After a period of service of about a year, an appreciable number of breakdowns occur, and this takes place even when the condensers are subjected to very severe tests before installation. Very similar results have also been observed in connexion with cables insulated by impregnated paper. There is now a very large amount of evidence which supports the view that the breakdown is due to the presence of air bubbles in the dielectric. It is found that when the voltage applied to the cable or condenser is increased, then at a certain voltage, called the critical or ionisation voltage, the power taken by the cable suddenly begins to increase rapidly. The assumption is usually made that if the dielectric be worked below the critical voltages then ionisation of the enclosed air cannot take place. The authors show both by experiment and theory that this is not the case. They explain some of the phenomena observed by recalling the experimental results obtained by Lord Rayleigh and others on the electrical properties of thin layers of air. It is known that however close together two electrodes are in air at atmospheric pressure, then ionisation does not ensue unless the voltage exceeds a number which is approximately 330. They utilise this theorem in the design of condensers. Instead of increasing the thickness of the dielectric, they build it up of a large number of thin sections in series in such a way that the voltage across any one section does not exceed that required for ionisation. The same effect can be produced by placing isolated conducting layers (interleaves) in the dielectric. Great advantages are stated to accrue from this method of construction.

HYDRAZINE HYDRATE SOLUTIONS.—The concentration of hydrazine hydrate solutions, which usually contain less than 30 per cent of available hydrazine, has hitherto been a matter of considerable difficulty, but a simple method of concentration is described by Hurd and Bennett in the *Journal of the American Chemical Society* for January. The hydrazine hydrate is mixed with a quantity of xylene and heated until the xylene has distilled away. The amount of xylene used determines the concentration of the residual hydrazine hydrate solution, and solutions containing up to 95 per cent hydrazine hydrate can be prepared in good yield at one distillation. The aqueous portion of the distillate contains a small quantity of hydrazine which may be recovered. Toluene may be used in place of xylene, but is less efficient; benzene is quite unsatisfactory. Attempts were made to prepare hydrazine by treating its salts with sodamide, calcium carbide, and aluminium carbide. With the two latter substances the desired reaction did not proceed, while sodamide reacted explosively unless diluted. The use of hydrocarbons as reaction media caused the reaction to proceed less violently, but only negligible yields of anhydrous hydrazine were obtained.

ARTIFICIAL ANALOGUE OF RUBBER.—The investigation of the problem of the chemistry of rubber by Staudinger and his school has been complicated in the past, on the natural side by the very great susceptibility of caoutchouc to oxidation, and on the synthetic side by the fact that the synthetic caoutchouc produced by condensation of the hydrocarbon isoprene may have a very different structure from the natural material, owing to the possibility of molecules uniting together into complex three-dimensional systems. A new approach to the subject is described by Prof. Staudinger in the January *Berichte* (vol. 62, pp. 241-263). Instead of isoprene, the aromatic compound styrene is condensed. This, being a benzene derivative, cannot furnish a true caoutchouc, but the condensed product which it gives, *polystyrene*, may be regarded as a 'model' of the natural substance, and can be accurately investigated, since its constituent groups can link together only in one single chain. An interesting discovery is that if the condensation is carried out at high temperatures, for example, 240° C., the product is relatively simple, being composed of some thirty units, whereas if the styrene is condensed slowly at ordinary temperatures it yields a very complex, colloidal substance, composed of some hundred thousand units, and resembling natural caoutchouc. All intermediate degrees of complexity are obtainable by varying the temperature and the time of condensation, and at any temperature the product obtained is a complex mixture of numerous members of a series, comparable with the series of natural paraffins; the most highly condensed products, and these only, resemble caoutchouc in viscosity, and in elastic and swelling properties. Prof. Staudinger concludes that natural caoutchouc is built up on a similar plan to polystyrene, and that it contains long chains of some thousand molecules of the unit 'polyprene,' $[C_5H_8]_8$.

Gravity Expedition of the U.S. Navy.

By Dr. F. A. VENING MEINESZ.

IN the course of 1928 an invitation from the Carnegie Institution of Washington was received and accepted to go to the U.S.A. with the apparatus for maritime gravity survey of the Netherlands Geodetic Commission. The U.S. Navy, having received a communication on this subject from the International Union of Geodesy and Geophysics, wished to organise an expedition for determining gravity in the Gulf of Mexico and the Caribbean Sea. The Secretary of the Navy, the Hon. Curtis D. Wilbur, designated the Naval Observatory for making the arrangements.

The expedition took place in the autumn of 1928. It consisted of the U.S. Submarine *S-21*, on board of which the observations were made, and two surface ships, the U.S. *Eagles 35* and *58*. The expedition was under the command of Lieutenant T. L. Nash, Captain of the U.S. *Eagle 35*, while Lieutenant J. L. Fisher had command of the U.S.S. *S-21*; officers of the submarine were Lieuts. F. S. Hall, F. D. Hamblin, and A. R. Sodergren. The scientific staff on board the *S-21* consisted of Dr. Fred. E. Wright, of the Geophysical Laboratory of the Carnegie Institution, Mr. Elmer B. Collins, principal scientist of the Hydrographic Office of the U.S. Navy, and myself.

The expedition started from Washington on Oct. 2 and completed the following schedule:

Leave	Arrive.	Number of Observations.
Oct. 1 Washington	Oct. 2. Hampton Roads	0
Oct. 4 Hampton Roads	Oct 8 Key West	3
Oct. 10. Key West	Oct 14. Galveston	7
Oct. 19. Galveston	Oct. 23. West Key via Mississippi Delta	7
Oct. 29. Key West	Nov. 2. Guantanamo (Cuba) via Bartlett Deep	8
Nov. 5. Guantanamo	Nov. 9. St. Thomas via Nares Deep	9
Nov. 15. St. Thomas	Nov. 19. Guantanamo via Caribbean Sea	6
Nov. 21. Guantanamo	Nov. 27. Washington	5

In addition, observations were made in all the harbours, of which Hampton Roads, Guantanamo, San Juan (during trip from Guantanamo to St. Thomas), and St. Thomas, were gravity stations, which have not been occupied before. The total number of new stations amounted therefore to 49.

The pendulum apparatus was mounted in the central control room of the ship; this was a favourable spot for making the observations, as it is near the metacentre of the ship, so that the rolling and the pitching cause only small translations of the apparatus. The apparatus is hung in gimbals, which makes it possible to work it even if the rolling or pitching is very great; a few observations have been made with a roll of 7° to both sides of the vertical, and with a slight modification of the gimbals it is hoped that in the future observations may be made with still larger angular movements. In this way it was often possible to work at periscope depth. During the return, however, from Guantanamo to Washington, the Atlantic was so rough near Cape Hatteras that the two observations which had been planned above the top and above the bottom of the continental slope could not be made, as the ship's movement at 100 feet depth exceeded the limit of 7°.

The apparatus used has been constructed at the workshop of the Meteorological Institute at De Bilt (Holland) by the chief mechanic L. M. van Rest; begun in 1925, it received its final shape in the spring of 1928 by the rearrangement of the photographic recording apparatus. It consists of a pendulum apparatus and a recording apparatus, combined in one unit hung in gimbals.

The pendulum apparatus contains three half-second pendulums swinging in the same plane; in order to avoid magnetic influences, brass pendulums are used, although of course their temperature constants are great. An insulating cover reduces the changes of temperature inside the apparatus. As, however, the central control room of the U.S.S. *S-21* showed less variation of temperature than the control rooms of the submarines with which I made previous voyages, the temperature inside the apparatus was likewise more stable; it seldom showed greater fluctuations than a few hundredths of a degree.

The pendulums are not recorded separately but combined in two pairs. For each pair the difference of the angles of elongation is recorded, and this angle may be considered as the angle of elongation of a fictitious pendulum of the same period as the original pendulums. It can be shown—and this is the fundamental principle of this method for determining gravity at sea—that the movement of this fictitious pendulum is free from the principal disturbing effect of the ship's movements: the effect of the horizontal accelerations. The records of the two pairs which the apparatus provides are therefore nearly regular; there remain only small disturbances by the vertical accelerations of the apparatus and by the tilt of the swinging-plane. The first is practically eliminated by taking the mean pendulum period over a sufficiently long period of observation; for this purpose half an hour is more than enough. The second makes it necessary to apply a certain correction to the result, which can easily be computed if the tilt is known. The apparatus is therefore provided with an auxiliary pendulum, which can move in a plane perpendicular to the swinging-plane and is damped in order to prevent its proper oscillations. The position of this pendulum with regard to the apparatus is recorded. This correction amounts only to a few units in the seventh decimal place of the second if the tilt is small, for example, not more than 10′; the gimbal suspension easily keeps it below this limit.

Besides the records which have been mentioned, two others are made; one of the temperature inside the apparatus and another of the middle pendulum alone. This last record is necessary for computing the reduction of the pendulum periods to infinitely small amplitudes; it is irregular because the movement of each pendulum is strongly disturbed, but as it is only used for the computation of a small reduction, this gives no special difficulties for the computations.

The records are provided with two series of time-marks by means of two shutters, which are actuated by electrical circuits opened and shut by two chronometers. Each shutter passes during a fraction of a second before the light-source which is used for recording purposes.

The rate of these chronometers is found by taking wireless time-signals; during the recent voyage the signals of Annapolis were used. Reception was effected by means of an auxiliary chronometer, provided by the Naval Observatory at Washington, the rate of which had been strongly deranged, so that every 65 seconds a full second coincidence could be observed with the signals, of which the rhythm is the same as of mean time. These coincidences were observed by ear through the well-known method of putting the contact of this chronometer in series with the telephone of the wireless. The appearances and the disappearances of the signals in the telephone have both been used.

The rates of the chronometers have been satisfactory, so that the uncertainty resulting from the fact

that the rate during the observation may deviate from the mean rate deduced from the time-signals will probably not amount to more than 2 or 3 millidynes in the result for the gravity.

The programme of the expedition was chosen with an eye to the numerous geophysical and geological problems in that part of the earth's crust. We may mention the question if isostasy prevails in the Gulf of Mexico in general and near or above the Mississippi delta; further, the problem of the Bartlett Deep south of East Cuba and the Nares Deep north of Porto Rico; the question of isostasy in the Caribbean Sea and in the Atlantic between Cape Hatteras and the West Indies, and, lastly, the gravity field above the continental slope for that part of the coast of North America.

Thanks to the whole-hearted co-operation of Captain Fisher, who ordered all the dives necessary for the measurements, this programme was fully accomplished. This involved a great deal of diving, often several times a day—once even five times in seventeen hours—which meant an additional strain for everybody. The helpful assistance of the captain, officers, and crew during the whole voyage in all circumstances may here be thankfully acknowledged.

Besides the pendulum observations a great number of soundings were taken. The submarine was provided with the sonic depth-finder of the U.S. Navy, which has given excellent results; not only during submergence, but also at the surface soundings were possible, so that the whole route could be covered. Over the ocean deeps the soundings were taken at short intervals, so that a detailed profile could be obtained.

The results of the gravity observations were provisionally computed during the voyage, and at the same time the isostatic reductions of the stations were made at the bureau of the U.S. Coast and Geodetic Survey, so that the complete provisional results were available a few days after the return of the expedition. The final computations are now being made at the Naval Observatory at Washington. Pending these, a definite interpretation is not advisable, but a few remarks concerning the provisional results may be given. It is not probable that the final results will change these conclusions.[1]

The Gulf of Mexico has shown a curious positive anomaly of about 60 millidynes over nearly its whole extent; only north of Yucatan it is somewhat less, but the anomaly is still positive. Towards Key West and Galveston this anomaly disappears. Returning from Galveston to Key West a special series of observations was made over the Mississippi delta in two profiles perpendicular to the contour lines of the sea bottom, in order to investigate the isostatic equilibrium of the earth's crust in that neighbourhood. It might be thought likely that deviations of equilibrium would occur because of the great load of material deposited by the river in the Gulf, but the results have not given any evidence in this direction. The slight positive anomaly which has been found seems rather to be in accordance with the general trend of anomalies in the Gulf, so that there is no reason to bring them in connexion with the delta and to assume a lag in the re-establishment of equilibrium.

A second result of importance has been found over the Nares Deep, north of Porto Rico. It is in harmony with the few values observed in that part during my former cruise with the Dutch submarine *K XIII* from Holland via Panama to Java. It shows great departures from isostatic equilibrium, which probably may be ascribed to stresses working in the earth's crust in connexion with the formation of the deep. Over the deep is a great deficiency of gravity; before reduction, it was more than 300 millidynes, and after isostatic reduction about 190 millidynes. North and south of the deep the anomaly after isostatic reduction is small; north of the deep it is slightly positive (± 25 millidynes), and south of it on the north coast of Porto Rico slightly negative (− 10 m.d.). The gravity in Porto Rico is yet unknown, but the U.S. Coast and Geodetic Survey is planning an expedition for supplying a series of land values in connexion with the results of the expedition, and a few stations on the island will be occupied so that in a short time the continuation of the gravity field through Porto Rico will be known. The importance of this land gravity expedition is obvious; it will complete the data which have been found. South of the island, positive anomalies of about 40 m.d. have been found, as has also been the case throughout the whole part of the Caribbean Sea which has been crossed. Summing up these results, we see that apparently the great deficiency of gravity above the deep is not accompanied by considerable positive anomalies in the neighbourhood, unless the values on Porto Rico should reveal any such anomalies.

Another result worth mentioning in connexion with the deep is that two stations north of the island of Haiti, both situated to the west of the Nares Deep, likewise show great negative anomalies (± − 120 m.d.), and even farther to the west, in two stations north of East Cuba, the anomaly is still negative (± − 40 m.d.). This seems to indicate that the stresses in the earth's crust which are causing the Nares Deep are not limited to the region of the deep itself, but continue much farther to the west. The topography itself does not reveal this.

The values of gravity found above the eastern part of the Bartlett Deep, south of East Cuba, show smaller anomalies after isostatic reduction than the Nares Deep; the greatest negative anomaly above the deep is − 61 m.d., while most of the anomalies found to the north or the south of the deep are less than ± 25 m.d. This gives the impression that the stresses in this part of the crust are smaller than those near Porto Rico.

Lastly, we will mention the results found in the Atlantic Ocean on the way back from Guantanamo to Washington. The three stations above deep water, which are all situated near the bottom of the continental slope, show small positive anomalies of about + 10 m.d., which contrast with the value of − 26 m.d. in Crooked Island Passage at the top of the slope and with the values found along the part of the Atlantic Coast to the south-west of Cape Hatteras by the U.S. Coast and Geodetic Survey, which are likewise negative; their mean value is − 24 m.d. We find here an analogous result, although somewhat less pronounced, to that found in 1926 by the *K XIII* on the west coast of Central and North America between Panama and San Francisco. In the latter case the values above the top of the slope were about normal and those above the foot positive, with a mean value of about 65 m.d.; the difference between the values above the top and the foot of the slope has the same sign, but is larger on the west coast than on the east coast.

Without wishing to enter into a premature interpretation of these results, we may mention two points. First, it seems difficult to explain these isostatic anomalies by a different location of the compensation masses from that assumed for the isostatic reduction, so that we appear to be forced to accept a deviation of equilibrium on these coasts. Secondly, an explanation of these disturbances of equilibrium on the west

[1] All the anomalies mentioned in this paper have been derived from gravity values, which are isostatically reduced according to the method of the U.S. Coast and Geodetic Survey.

coast by a westward drift of the American continent and a corresponding pressure on the ocean floor, seems not in harmony with the results which have now been found on the east coast; in this case the reverse might be expected—a negative anomaly above the foot of the continental slope behind the moving continent.

Before and after the expedition, base observations were made with the apparatus both in the gravity base station, Washington, of the U.S. Coast and Geodetic Survey, and in the Netherlands gravity base station, De Bilt. These observations provide, therefore, a new check on the comparison of Washington with the international base station Potsdam. The final computations and the application of the final corrections of the time-signals have to be awaited before any conclusions will be possible.

The expedition has doubtless meant an important step for geodetic and geophysical science: because of the immediate results of which a short sketch has been given in this article, but still more because of future possibilities should the U.S. Navy continue this research. Results of great importance and extent might then be expected. The expedition has been made possible by the co-operation of the U.S. Navy with the Carnegie Institution and the Dutch Geodetic Commission. Sincere thanks may be expressed to the Secretary of the U.S. Navy, the Hon. Curtis D. Wilbur; to Admiral Hughes, Chief of Naval Operations; to Admiral Leigh, Chief of the Bureau of Navigation; also to Captain Freeman, Superintendent of the Naval Observatory, for his indefatigable work in preparing the expedition.

Personally, I wish to acknowledge the kind reception accorded me everywhere, in Washington, in naval as well as in scientific circles, on board the U.S.S. *S-21* and the other ships, and ashore in the different ports which have been touched, where the naval authorities or, in St. Thomas, the Governor of the Virgin Islands, gave me a most cordial welcome.

Zoological Exploration of Mongolia.

In the summer, 1928, the Russian Academy of Sciences sent a zoological expedition to Mongolia, under the direction of A. Y. Tougarinov, who gives a short preliminary account of it in *Priroda*, No. 12, 1928. The problem of the expedition was the study of the Mongolian fauna to the east of Urga, a region which so far had not been zoologically investigated. The expedition took the route south-east of Urga. Plains, with occasional chains of comparatively low mountains, or individual peaks, distinguished by extreme poverty and uniformity of fauna, stretch east of Urga practically to Hingan.

The expedition was astonished by the great numbers of *Microtus brandti*, whose colonies stretch for tens of kilometres. There are no large mammals, with the exception of rare antelopes; at times colonies of tarbagans were met. The characteristic birds are *Haliæetus leucoryphus*, *Buteo hemilasius*, and the desert larks. Such poor landscape stretches up to Hingan, and only after 50 kilometres is a change observed. Owing to the humid conditions, the semi-desert is gradually transformed into a steppe, the herbaceous carpet is thicker, gramineous plants and other densely leaved steppe grasses are predominant. A grassy steppe takes the place of the xerophytic flora. The representatives of desert, such as the sandgrouse, disappear, and dwellers of steppe and forest begin to appear, which shelter in the elm forests of the valley of Chalhin-gol. Representatives of Manchurian fauna such as *Xanthopygia tricolor*, *Pica sericea*, *Circus melanoleucus* are met with. The expedition observed a great flight of birds across Chalhin-gol, the species being characteristic of taiga and the tundra of eastern Siberia. It may be assumed that here around Mongolia and along Hingan lies the migratory route of east Siberian birds, the origin of which is known to have been in the south-east of Asia.

Summing up the character of the explored region, it may be said that besides the Mongolian and Manchurian provinces mentioned, the rest of eastern Mongolia may be considered as one district, the chief characteristic of which is the predominance of central Asiatic fauna. Series of species characteristic and usual to regions south of Urga are absent (for example, *Podoces hendersoni*, *Accentor fulvescens*, *Emberiza godlewskii*). Their absence cannot always be explained by the lack of suitable habitats. The Turanian elements and the forms of the southern Palæarctic are also absent. All this leads to the conclusion that recently the country has been exposed to conditions which have impoverished the fauna and hindered the spreading of forms from east and south. The extreme desert state and the xerothermic climate were probably the required conditions.

University and Educational Intelligence.

Cambridge.—Dr. N. E. Goldsworthy, of Clare College, has been elected to the John Lucas Walker studentship for three years. This studentship was founded for the furtherance of original research in pathology and is of the value of £300 a year for three years.

Smith's prizes have been awarded to H. D. Ursell, of Clare College, and J. M. Whittaker, of Trinity College. Rayleigh prizes have been awarded to J. Hargreaves, of Clare College, J. G. Semple, of St. John's College, and S. Verblunsky, of Magdalene College.

Edinburgh.—At the meeting of the Senatus held on Mar. 14, it was announced that His Royal Highness Prince George has consented to visit the University on May 15 to open the new Department of Zoology.

At the same meeting the Senatus resolved to offer the honorary degree of doctor of laws to the following among others: Prof. E. S. Goodrich, Linacre professor of zoology and comparative anatomy, University of Oxford; Prof. A. V. Hill, Foulerton research professor of the Royal Society; Prof. C. E. Inglis, professor of mechanics and applied mechanics, University of Cambridge; Dr. A. P. Laurie, formerly principal of Heriot-Watt College; Sir James Walker, emeritus-professor of chemistry of the University of Edinburgh; and the Right Hon. Baron Woolavington of Lavington.

Manchester.—Sir Ronald Ross, Director-in-Chief of the Ross Institute and Hospital for Tropical Diseases, the discoverer of the life-history of malaria parasites in mosquitoes, is among those on whom it is proposed to confer the honorary degree of D.Sc. on May 15.

St. Andrews.—H.R.H. The Duchess of York has signified her willingness to be present at the opening on June 28 of the Graduation Hall gifted to the University of St. Andrews by James Younger, of Mount Melville, St. Andrews, and Mrs. Younger. After performing the opening ceremony, Her Royal Highness will receive the honorary degree of doctor of laws.

Prof. C. E. Weatherburn, of Canterbury College, Christchurch, New Zealand, has been appointed to the chair of mathematics in the University of Western Australia.

Applications from medical women are invited for the William Gibson research scholarship, value £292 per annum, and tenable for two years. The applications should reach the Secretary, Royal Society of Medicine, 1 Wimpole Street, W.1, by June 1 at latest.

The sixth vacation course in terrestrial and aerial photogrammetry will be held at the Technical-Physical Institute of the University of Jena on April 8–20. Practical work will be arranged in connexion with the lectures, the necessary apparatus being provided by Messrs. Carl Zeiss. Particulars can be obtained from A. Kramer, Schützenstr. 72, Jena.

An election to Beit fellowships for scientific research will take place in July next. The latest date for the receipt of applications is April 16. Forms of application and all information respecting the fellowships are obtainable by letter from the Rector, Imperial College of Science and Technology, South Kensington, S.W.7.

The Board of Education is again prepared to receive applications for full-time studentships from teachers of not less than five years' standing, desiring financial assistance in order to attend approved full-time courses of advanced study at universities or other institutions at home or abroad. The amount of grant will not exceed £100 for an academic year. The Board is also prepared to consider proposals involving travel or the practical study of industrial conditions connected with the teaching of technical subjects. Applications for the year 1929–30 should be made as soon as possible. Further information can be obtained from the Board of Education, Whitehall, London, S.W.1.

A scientific survey of secondary education in England and the United States has been initiated by the Division of Secondary Education of the University of Pennsylvania with the co-operation of committees in both countries. The English committee, of which Dr. Cyril Norwood (Harrow) is chairman and Mr. C. W. Bailey (Holt School, Liverpool), secretary, met on Mar. 9, and in the light of information given by Prof. E. D. Grizzell, of Pennsylvania, who is spending the year in England and has already accomplished much preliminary work, approved a scheme based on the selection of some fifty representative schools. Many of the problems confronting secondary education to-day are common to both countries, and this joint inquiry should prove helpful. The rapid growth since the War in the numbers of schools and pupils has been accompanied by the creation of new types of school and modifications of the old to meet changed conditions, and there has been an enormous amount of research and experimentation in this field, of which the joint survey will doubtless take cognisance. Of special interest at the present time are the numerous important researches recently conducted under the auspices of the Iowa Research Conference on Commercial Education, the survey of secondary commercial education in Minnesota and other studies, described in the report for 1927–28 of the United States Commissioner of Education, designed to contribute to improvement of instruction in commercial departments of secondary, normal, and collegiate schools.

Calendar of Patent Records.

March 24, 1802.—To Richard Trevithick, one of the greatest of British engineers and inventors, we owe the introduction of the high-pressure steam-engine, a patent for which was granted to him, in conjunction with Andrew Vivian, on Mar. 24, 1802. The specification describes also a steam-carriage to which at that time Trevithick attached considerable importance though he abandoned it after a few years of not very successful experiment. The first locomotive to run on a railway was, however, the outcome of these experiments. This was constructed by Trevithick, and ran at the Pen-y-darren Iron Works near Merthyr Tydfil for a few months in 1804.

March 25, 1840.—The commercial success of electro silver-plating was founded on the patent granted to George Richard Elkington and Henry Elkington, of Birmingham, on Mar. 25, 1840. The idea of using the double cyanide of silver and potassium was due to John Wright, a Birmingham surgeon, who had been working independently in the same field, and, arriving in London to secure patent rights for his process, met George Elkington, then engaged on the preparation of his patent specification. The two agreed to work together, and on the satisfactory demonstration of Wright's process, this was incorporated into the Elkingtons' specification.

March 27, 1886.—The first commercial process to utilise successfully the action of diastase on starch in breadmaking was employed in the making of 'Bermaline' bread, under a patent which was granted to John Montgomerie of Lanark on Mar. 27, 1886.

March 28, 1764.—A step was taken towards the machine production of lace by the patent granted to Thomas Morris and others on Mar. 28, 1764, for a new machine "which is to be fixed to a stocking-frame for making oilett holes or network in silk, thread, cotton, or worsted, as mitts, gloves, hoods, aprons, handkerchiefs, and other goods manufactured on stocking-frames." The idea of the new machine seems first to have occurred to a stocking-maker of Mansfield named Butterworth, who, with the object of having a machine made, confided it to John Betts, a smith. Betts, however, obtaining financial support from Thomas and John Morris, hosiers, of Nottingham, took the invention to London, where the patent was granted in the joint names of the Morrises and Betts. The patent was afterwards assigned to John Morris, and the invention was successfully applied in Nottingham, the knitting industry of which reaped considerable benefit from its introduction.

March 28, 1787.—During the last few years of the eighteenth century, many experiments were made in England, America, and France in the application of the steam-engine to navigation. Amongst these, and the first to receive a practical trial in the United States, was the invention of John Fitch, who was granted a patent by special Act of Assembly for the State of Pennsylvania on Mar. 28, 1787. A steam-boat, according to Fitch's specification, moved by twelve oars or paddles working perpendicularly after the manner of the paddle of a canoe, six paddles entering the water as the remaining six are raised, was built in Philadelphia, and ran on the River Delaware in 1788 carrying more than thirty persons a distance of 20 miles in 3 hours 10 minutes.

March 28, 1907. The control pillar or 'joy-stick' in almost universal use in aeroplanes was the invention of Robert Esnault-Pelterie, who was granted a French patent on Mar. 28, 1907, in which an aeroplane with warping wings and elevators controlled by one lever was for the first time described. A corresponding English patent was applied for in January 1908.

Societies and Academies.

LONDON.

Institute of Metals, Mar. 13.—P. Saldau: Special properties of eutectics and eutectoid alloys in binary metallic systems. As regards hardness and electrical resistance, the eutectic occupies an abnormal position on the property-composition curve, even in drastically annealed alloys. For coalescence to occur, an excess of one of the phases is necessary.—**F. Hargreaves** and **R. J. Hills:** Work-softening and a theory of intercrystalline cohesion. For work-softening there must be more than one phase present and, roughly, *both* constituents must undergo spontaneous annealing after working at air temperature. A theory of intercrystalline cohesion is outlined. Briefly, it postulates the existence of a transition zone between two orientations. Work-hardening and work-softening are identical phenomena concerning the early stages of the latter. The pronounced softening caused by heavy working is attributed to interphase boundary action and the retention of the individual phases in a quasi-viscous condition.—**P. J. Durrant:** The constitution of the cadmium-rich alloys of the system cadmium-gold. The constitution of the alloys of cadmium and gold from 0 to 48 atoms per cent of gold has been reinvestigated by thermal and micrographic analysis. Saldau's equilibrium diagram, published in 1915, has been modified. A new area of solid solution has been detected (phase III) which lies in the field described by Saldau as containing $\beta+\gamma$. This solid solution undergoes two polymorphic changes—one at about 500° C., and the other at about 375° C., the latter being analogous to the change in the β-phase of brass at 460° C. No evidence was obtained for the existence of the compound $AuCd_3$ at the liquidus, but the form of the equilibrium diagram suggests the existence of two compounds, Au_2Cd_5 and Au_2Cd_3, both of which are much dissociated at high temperatures.—**Marie L. V. Gayler** and **G. D. Preston:** The age-hardening of some aluminium alloys. Five typical aluminium alloys containing copper, magnesium silicide, or both, have been examined. Changes in density and lattice parameter which take place during ageing suggest that precipitation from solid solution takes place. X-ray analysis shows also that the crystals themselves are in a disturbed state, which is gradually relieved by further ageing at high temperatures. The increase in electrical resistance on ageing corresponds to this distortion of the space lattice of the solid solution, caused by the presence of minute particles due to the decomposition of the solid solution.—**Clement Blazey:** Brittleness in arsenical copper (2). Under certain conditions, about 0·004 per cent of bismuth can produce a susceptibility to brittleness. The conditions are: plain melting under charcoal of arsenical copper of the quality used, followed by poling and the addition of bismuth before casting. The addition of phosphorus after bismuth destroys the susceptibility or it may be removed by remelting.—**W. Hume-Rothery** and **E. O. Rounsefell:** The system magnesium-zinc. The equilibrium diagram of the system magnesium-zinc has been investigated in the range 0 to 70 atomic per cent magnesium. Particular attention has been paid to the structure of the solid alloys and the limits of solid solution in the various phases. The compound $MgZn_5$, discovered by Chadwick, and $MgZn_2$, discovered by Grube, have been confirmed. A new compound, MgZn, has been shown to exist, and this also is of fixed composition. It may be distinguished from $MgZn_2$ by means of Benedicks' reagent. The compound is formed at 354° C. by a peritectic reaction between $MgZn_2$ and liquid. On the practical side, the present work shows that in elektron metal, and similar alloys, any zinc present in excess of that contained in solid solution in magnesium will exist in the form of the new compound MgZn, and not, as previously supposed, as $MgZn_2$.

Geological Society, Feb. 20.—C. A. Matley: The basal complex of Jamaica, with special reference to the Kingston district. With petrological notes by **F. Higham.** There is a basal complex of great thickness, unconformably underlying Upper Cretaceous and Eocene rocks. The 'granite and syenite' of the Survey—chiefly a granodiorite—is an important plutonic member of the complex, and contributes abundant pebbles to overlying Upper Cretaceous and Eocene conglomerates. Another plutonic member of the complex is a peridotite of Harzburg type, now converted to serpentine. The other members of the complex, many of which are found in a metamorphic condition, were originally sediments and volcanic lavas and tuffs. The metamorphism appears to be late Palæozoic (Hercynian) or even older. No trace of fossils has been found in the complex. Comparison is made with similar rocks in Cuba, Hispaniola (Haiti and Santo Domingo), Porto Rico, and the Virgin Islands. With the exception of Porto Rico, Jamaica now falls into line, as regards the presence of a pre-Cretaceous basement, with the other islands of the Greater Antilles, although there is still want of agreement as to the ages of the rocks of that basement.

Physical Society, Mar. 8.—Ezer Griffiths and **J. H. Awbery:** The dependence of the mobility of ions in air on the relative humidity. The apparatus employed was a modification of Zeleny's original method; the end of a wind channel being closed by a disc of gauze fitted with a guard ring through which a steady stream of air of definite humidity was pumped. The motion of the negative ions due to the action of the air stream was balanced by a counter potential gradient, and the mobility deduced from the critical potential required to produce a balance.

LEEDS.

Philosophical and Literary Society, Feb. 19.—W. P. Milne: Three theorems on the cubic surface.—**A. O. Allen:** A simplified derivation of v. Seidel's aberration formulæ.—**W. H. George:** X-ray examination of insulin, edestin, and hæmoglobins. Only the powder method could be applied.—**G. W. Brindley:** Distribution of charge on the carbon atom. The F curve calculated for the carbon atom model does not agree quantitatively with the experimental curve. The disagreement is most noticeable for large values of sin θ for which the theoretical curve is known with most certainty.—**H. M. Dawson** and **G. Claxton:** The miscibility of phenol with aqueous solutions of electrolytes. If S and C represent the molar concentrations of the phenol and the electrolyte in the aqueous phase, then for a wide range of C values the experimental results are accurately reproduced by the formula $S=S_0C^{-kc}$, where S_0 is the value of S for $c=0$, and k is a constant which varies with the nature of the electrolyte. The results suggest that the miscibility is not appreciably affected by the interionic forces which are associated with the presence of the salt.—**C. K. Ingold** and **H. Burton:** The existence and stability of free radicals. The basis of the theory is the principle of electronic exclusion, which is also regarded as the radical cause of tautomerism.—**W. H. Pearsall:** Form variation in *Ceratium Hirundinella* O.F.M. Statistics as to its variation in size and form in Rostherne Mere support the view that the

population is composed of a single race of this species. The form variation shows three phases, and an explanation of the changes in size is advanced, based on the differential rates of protoplasmic growth and cell wall formation.—**R. G. S. Hudson**: On the lower carboniferous corals: *Orionastræa* and its distribution in the north of England. The northern forms, with the exception of those from the D_2 zone, belong to other groups than that of *Orionastræa phillipsi* or *O. placenta* and have therefore been described as new species and a structural sequence established.

Paris.

Academy of Sciences, Feb. 11.—**G. Charpy** and **L. Jacque**: The reduction of the sulphates of the alkaline earths in metallurgical operations. From the experiments described it is concluded that although it may be true that in certain metallurgical operations barium sulphate does not introduce so much sulphur into the casting as calcium sulphate, this is not due to a difference in the chemical properties of the two sulphates but to certain physical peculiarities, more especially the fusibility of the slag.—**A. Khintchine**: The law of large numbers.—**S. Serghiesco**: The number of roots common to several simultaneous equations.—**Charron**: A curious gyroscopic phenomenon.—**E. Huguenard** and **A. Magnan**: An apparatus for the comparison of aerodynamical velocities round an aeroplane.—**Dussaud**: Apparatus for the blind.—**A. Auric**: The ring of asteroids. An examination of the distribution of the asteroids with respect to their distance from the sun leads to the conclusion that the asteroids do not constitute one homogeneous family, but a mixture of two families differing in their origin and their constitution. The study of the distribution of the eccentricities and the inclinations of the orbits leads to the same conclusion.—**Thadée Banachiewicz**: The ellipticity of the terrestrial equator.—**Z. Horàk**: The wave equation of Schrodinger.—**Vasilesco Karpen**: The equations of state and thermodynamics. Reply to some criticisms by M. Verschaffelt.—**B. Decaux**: The measurement of very high radiotelegraphic frequencies by means of piezo-electric quartz oscillators.—**A. Travers** and **Nouvel**: The solubility of $Mg(OH)_2$ at high temperatures. Special attention was given to the preparation of a pure magnesium hydroxide, and in the experiments at high temperatures glass vessels were replaced by copper flasks. The solubility becomes inappreciable at 178° C.—**Lespieau**: A heterocyclic diacetylene derivative. The interaction of the dimagnesium compound of acetylene on symmetrical dichlormethyl ether gives rise to a substance the properties of which are consistent with the formation of a ring compound with eight carbon atoms and two oxygen atoms in the ring.—**L. Blanchard**: Some derivatives of cyclobutanol.—**Henri Moureu**: The tautomerism of the α-diketones. The two tautomeric forms of phenylbenzylglyoxal and of phenylanisylglyoxal.—**L. Meunier** and **R. Guyot**: The absorbent properties of cellulose fibres after treatment with formol in acid solution.—**J. Savornin**: The artesian hydrogeology, hydraulics, and thermodynamics of the eastern Sahara.—**Ch. Killian**: The development and biology of *Ambrosinia Bassii*.—**P. J. Shiwago**: The chromosome complex of the chicken and turkey.—**Jules Lefèvre**: Bioenergetics and its new laboratory.—**C. Levaditi** and **P. Lépine**: Experimental herpetic encephalitis of the ape.

Prague.

Czech (Bohemian) Academy of Arts and Sciences (2nd class, Natural Sciences and Medicine), Jan. 11.—**F. E. Vološin**: A new ice pyrheliometer.—**F. Čechura**: Magnetic declination in Bohemia in 1925·5. The following communications of members of the 2nd class of the Academy were presented to be incorporated in a jubilee volume in commemoration of the tenth anniversary of the foundation of the Czechoslovak Republic.—1. **B. Brauner**: Some physiologico-optical experiments.—2. **B. Bydžovský**: Symmetric involutions of the fifth order.—3. **E. Čech**: Asymptotic correspondences between two surfaces.—4. **K. Domin**: The hybrids and the garden forms of the genus *Pityrogramma*.—5. **J. Hanuš**, **A. Jílek**, and **J. Lukas**: Parabrom-benzol-aceton, its iso-nitroso-compound and dioxime.—6. **J. Hanuš** and **J. Voříšek**: The action of hydrazine hydrate on some unsaturated acids of the series $C_nH_{2n-2}O_2$, $C_nH_{2n-4}O_2$, $C_nH_{2n-6}O_2$.—7. **F. Hasa**: The quality of butt and molten electrical weldings.—8. **J. Heyrovský** and **S. Berezicky**: The deposition of radium and other alkaline earth metals at the dropping mercury cathode.—9. **I. Honl-Ungarn**: Properties of bacteriophages.—10. **R. Kettner** and **F. Slavík**: A new profile in Algonkian and Cambrian of Tejřovice.—11. **J. Křepelka**: A study of perselenic acid.—12. **V. Láska**: Hyetometry in mountainous countries.—13. **B. Němec**: Immunity in plants.—14. **M. Pelíšek**: Space rolling of a hyperbola on a congruent hyperbola.—15. **J. Pelnář**: The cancer of *Micterus* and our clinical experience.—16. **K. Petr**: The composition of binary quadratic forms.—17. **V. Posejpal**: Resonance spectra and the Raman effect.—18. **C. Purkyně**: The Carboniferous and Permian formations in western outskirts of Krkonoše (Giant's Mountains). 19. **V. Rosický**: Two articles on the study of crystal properties.—20. **K. Rychlík**: The extension of the idea of congruence.—21. **J. Štěrba-Bohm** and **S. Škramovský**: Complex oxalates of scandium.—22. **V. Trkal**: The equation of the wave-propagation in the wave-mechanics and Hamilton's principle.—23. **J. Vilhelm**: Verdant and proliferous flowers of some plants.—24. **E. Votoček-V. Prelog**: The 3, 12-di-hydroxy-palmitic acid, a non-sugar component of rhamno-convolvulic acid.—25. **K. Weigner**: Physical education respecting constitution and sex.—26. **J. Wenig**: The structure of secondary envelopes of chords in *Ammocetes*.—27. **J. Wenig**: A peculiar phenomenon in the abnormal growths of incisor teeth of Rodentia. 28. **F. Záviška**: The translation of circular cylinders through a viscous liquid.

Feb. 8.—**J. Paroulek**: The action of liver and ligamentic tissues on the exogenic uric acid. **J. Scheiner**: The lipoid nephrose. **V. Jedlička**: The pathogenesis and etiology of pernicious anæmia. **S. Prát** and **Z. Kobza**: The chemical composition of some Algæ.—**J. Babička**: The Bohemian Travertins.—**B. Brauner**: 'Analysis of water from the pond 'Babylon.'

Washington, D.C.

National Academy of Sciences (*Proc.*, Vol. 14, No. 12, Dec. 15).—**Raymond Pearl**, **Charles P. Winsor**, and **Florence Barclay White**: The form of the growth curve of the canteloup (*Cucumis melo*) under field conditions. The growth of seedlings of this plant in the field, as in the laboratory, without exogenous food and light, can be represented by a generalised logistic curve. The experiments suggest that, to a first approximation, the rate of growth is identical whether the environment is constant or highly varied, that is, it is determined by the organism itself. Food from the soil, etc., is only a means of prolonging its life. **E. T. Bell**: Invariant sequences. **A. Adrian Albert**: (1) Normal division algebras satisfying mild assumptions.—(2) The group of the rank equation of any normal division algebra.—**Morgan Ward**: Postulates for an abstract arithmetic. **Einar Hille** and **J. D.**

Tamarkin : (1) On the characteristic values of linear integral equations.—(2) On the summability of Fourier series.—**G. A. Miller** : Groups involving a cyclic, a dicyclic, or a dihedral group as an invariant subgroup of prime index.—**Ancel B. Keys** : The weight-length relation in fishes. It is shown statistically that this relation is given by {weight = constant × (length)^n}, where n is between 3 and 4. The form of a fish changes during growth, and the paper gives a method of calculating the magnitude of the change.—**Gordon D. Snell** : A cross-over between the genes for short-ear and density in the house mouse. The detection of one cross-over shows that the genes for short-ear and density, although borne in a common chromosome, are not at identical loci.—**Mildred S. Moses** and **Chas. W. Metz** : Evidence that the female is responsible for the sex ratio in *Sciara* (Diptera). Breeding shows that certain females are female-producers and others male-producers, regardless of males with which they mate, fertilisation being by the first male used in mating.—**Chas. W. Metz** and **Mildred S. Moses** : Observations on sex-ratio determination in *Sciara* (Diptera). Sex-ratio is probably determined by a simple Mendelian inheritance of a single pair of factors for which female-producing females are heterozygous and male-producing females and males are homozygous and recessive.—**John Warren Williams** : The relation between polarisation and association. A development of Debye's theory that association in liquids depends on the interaction of the dipoles.—**L. W. Elder, Jr.**, and **W. H. Wright**. *p*H measurement with glass electrode and vacuum tube potentiometer. A quadrant electrometer is generally used with the glass electrode for electrometric work with substances affected by platinum. A vacuum tube potentiometer gives consistent results and the only precaution necessary is that it must be set up in a dry atmosphere.—**Carl Barus** : Chemical reaction in the interferometer U-gauge.—**P. W. Bridgman** : Resistance and thermo-electric phenomena in metal crystals. By an improved method of making single metal crystals, it has been possible to cast from the same melt a number of single crystal rods of a wide range of orientation. The general results indicate that the Kelvin-Voigt symmetry law for thermal e.m.f. is an approximation. The detailed paper is to appear in *Proc. Am. Acad. Sci.*—**Ronald W. Gurney** : Angular distribution of intensity of resonance radiation. It has been assumed that the emission of resonance radiation will be distributed at random in direction ; this assumption seems to be unwarranted. If the plane of polarisation of plane polarised light is rotated rapidly, consideration of the movement of the atomic oscillators shows that though the intensity along the beam is unaltered, in other directions it is modified. This must be taken into account in intensity measurements of resonance radiation.—**Stanley Smith** : Some multiplets of singly ionised thallium.—**J. D. Hanawalt** : The influence of the presence of hydrogen on the L III X-ray absorption edge of palladium. Whether the hydrogen is occluded electrolytically or in a hydrogen furnace, there is X-ray evidence of the presence of the chemical compound of formula Pd_2H, with a face-centred cubic lattice in which alternate grating points are PdH molecules, the remaining points being occupied by Pd atoms.—**Harlow Shapley** : Studies of the galactic centre. (3) The absolute magnitudes of long period variables.—**B. P. Gerasimovič** : The absolute magnitudes of long period variable stars. A period-luminosity relation is obtained : for a period of 100-250 days, mean absolute visual magnitude is −2·3, for a period of 250-340 days it is −1·1, and for a period greater than 340 days it is +0·3.

Official Publications Received.

BRITISH.

Memoirs of the Asiatic Society of Bengal Vol. 11, No. 1 : Diaries of Two Tours in the Unadministered Area east of the Naga Hills By J. H. Hutton Pp 72+16 plates. (Calcutta.) 11.13 rupees.

The Indian Forest Records Silviculture Series, Vol. 13, Part 3 : Commercial Volume Tables for *Sal* (*Shorea robusta*) in the Wet Mixed Forests of the *Bengal Duars*. By Parma Nand Suri Pp. ii+25+2 plates. 6 annas, 8*d*. Silviculture Series, Vol. 13, Part 4 ; Volume Tables for *Sundri* (*Heritiera Fomes*, *Buch*, Syn. *Heritiera minor*, Roxb.) in the Sundarbans, Bengal. By Parma Nand Suri Pp ii+49+2 plates. 10 annas, 1*s*. (Calcutta : Government of India Central Publication Branch.)

Memoirs of the Geological Survey of India Palæontologia Indica, New Series. Vol. 9, Memoir No 2 Revision of the Jurassic Cephalopod Fauna of Kachh (Cutch), Part 3. By Dr. L. F. Spath. Pp. 161-278+plates 20-47. (Calcutta : Government of India Central Publication Branch.) 15.4 rupees ; 24*s*. 6*d*.

Empire Cotton Growing Corporation Reports received from Experiment Stations, 1927-28. Pp. xii+278+12 plates (London)

Geological Survey Department, Tanganyika Territory Short Paper No. 1 : Outlines of Geology of the Regions adjoining the South-Eastern Shores of Lake Victoria. By F. B Wade. Pp iv+24+1 map. Short Paper No. 2 : Lupa Gold Field. By Dr. D. R Grantham. Pp. ii+6+2 maps Short Paper No. 3 : Kigugwe Copper Deposit near Brandt's. By G. M. Stockley. Pp. ii+8+1 map. Annual Report, 1927 Pp. 60+2 maps. 5*s*. (Dar es Salaam : Government Printer.)

Department of Agriculture, Tanganyika Territory Pamphlet No 3 : Tea Cultivation. By M. F. Bell. Pp 12+1 plate. Tea Planting Prospects in the South-Western Highlands of Tanganyika. By M. F. Bell Pp ii+32 (Dar es Salaam : Government Printer.)

Institute of Physics. The Presidential Address on Physics in Astronomy, given before the Institute on May 15, 1928 Pp. 15. 1*s*. net. The Physicist in the Glass Industry, given before the Institute of Physics on May 25, 1927. By Prof. W. E S. Turner. (Physics in Industry : Lecture No. 12) Pp. 22+6 plates. 1*s*. net Physics in the Food Industry, given before the Institute of Physics on November 14, 1927. By Sir William Hardy (Physics in Industry : Lecture No 13.) Pp. 21+2 plates 1*s* net The Physics of Photography, given before the Institute of Physics and the International Congress of Photography on July 12, 1928. By Dr. C E Kenneth Mees (Physics in Industry : Lecture No. 14) Pp 20+1 plate. 1*s* net (London)

Proceedings of the Royal Society of Edinburgh, Session 1928-1929. Vol. 49, Part 1, No 1 : The Theory of Bigradients from 1861 to 1919. By Sir Thomas Muir. Pp. 15. 1*s*. 3*d*. Vol 49, Part 1, No. 2 : Mathematical Consequences of certain Theories of Mental Ability. By John Mackie. Pp. 16-37. 2*s*. Vol. 49, Part 1, No. 3 On a Quadrature Formula for Trigonometric Integrals. By Prof. L. N. G. Filon. Pp. 38-47. 1*s*. Vol. 49, Part 1, No 4 : The Fulcher Bands of Hydrogen By Dr. Ian Sandeman. Pp. 48-64. 1*s*. 6*d*. (Edinburgh : Robert Grant and Son : London : Williams and Norgate, Ltd)

Pharmaceutical Society of Great Britain : Pharmacological Laboratories. Third Annual Report, 1928. Pp. 19. (London.)

Proceedings of the Cambridge Philosophical Society. Vol. 25, Part 1, January. Pp 120. (Cambridge : At the University Press.) 7*s*. 6*d* net.

Students from other Countries in the Universities and University Colleges of Great Britain and Ireland, Session 1928–29. Pp 33. (London : Universities Bureau of the British Empire.) 1*s*

Leeds Public Libraries What to Read on Zoology. By Prof. J. Arthur Thomson. Pp. 39. 3*d*. What to Read on Biology. By Prof. William John Dakin. Pp. 32. 3*d*. (Leeds)

The South African Journal of Science. Vol. 25 : Being the Report of the Twenty-sixth Annual Meeting of the South African Association for the Advancement of Science, Kimberley, 1928, 29 June to 5 July. Pp. xliv+526. (Johannesburg) 30*s*. net.

The Imperial College of Tropical Agriculture. Prospectus for 1929-30, also Principal's Report for 1927–28 and Register. Pp. 38+2 plates. (St Augustine, Trinidad, and London.)

Air Ministry Aeronautical Research Committee. Reports and Memoranda No 1171 (Ae. 335) : The Theoretical Relations for an Aerofoil with a Multiply Hinged Flap System. By W. G A. Perring. (T. 2632) Pp. 14+3 plates. 9*d*. net No. 1174 (Ae. 338) : Wind Tunnel Tests with High Tip Speed Airscrews ; Some Experiments upon an Airscrew of Conventional Blade Section, Aerofoil R. and M. 322, No. 3, at High Speeds. By Dr. G. P. Douglas and W. G. A. Perring. (T. 2652.) Pp. 8+4 plates. 9*d*. net. No. 1176 (Ae. 340) : The Boundary Layer of the Front Portion of a Cylinder. By Dr A. Thom (T 2553 and A) Pp. 20+7 plates. 1*s* net. No. 1180 (Ae. 344). The Inclusion of Partial Glides in Routine Performance. By A. E. Woodward Nutt (T 2626.) Pp. 3+2 plates. 4*d*. net. No. 1182 (Ae. 346) : Rolling Experiments on an Aerofoil of R A F. 32 Section. By H. B. Irving and A S Batson. (T. 2649) Pp. 8+3 plates. 6*d*. net. (London H.M. Stationery Office.)

FOREIGN.

Meddelanden från Statens Meteorologisk-Hydrografiska Anstalt. Band 4, No 7 ; De svenska vattendragens arealforhallanden. 6 : Ångermanalven och indalsalven m fl (Vattendragen mellan umealvs och ljungans områden.) Av Gustaf Wersén. Pp. 24. 2.50 kr. Band 4, No 10 : Tåkern en hydrografisk Undersokning. Av Ragnar Melin. Pp. 72 +6 planscher. 5.00 kr. Band 5, No. 1 : Vaderlekens samband med Halsotillståndet. Av Axel Wallén. Pp. 71. 3 00 kr. Band 5, No 2 Eine neue Methode zur Bestimmung des Wassergehaltes der Wolken, Von Hilding Kohler. Pp. 11. 1 00 kr. (Stockholm.)

Abisko Naturvetenskapliga Station. Observations météorologiques à Abisko en 1926. Redigées par Bruno Wolf. Pp. iv+66. Observations météorologiques à Abisko en 1927 Redigees par Bruno Wolf. Pp. vi+66 (Uppsala : Almquist and Wiksells Boktryckeri A.-B)

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Wisconsin Geological and Natural History Survey. Bulletin No. 69, Economic Series No. 23: Molding Sands of Wisconsin. By David W. Trainer, Jr. Pp. 103. (Madison, Wis.)

The University of Chicago: Publications of the Yerkes Observatory. Vol. 4, Part 7: Astrometric and Photometric Statistics of certain of Hagen's Fields photographed with the 24-inch Reflector. By Harriet McWilliams Parsons. Pp. v+32+plates 8-9. (Chicago: University of Chicago Press; London: Cambridge University Press.) 7s. 6d. net.

Scientific Papers of the Institute of Physical and Chemical Research. No. 172: The Slip-Bands produced when Crystals of Aluminium are Stretched. Part 2: Extension at High Temperatures. By Keiji Yamaguchi and Sakuichi Togino. Pp. 277-292. (Tokyo: Iwanami Shoten.) 35 sen.

Carnegie Institution of Washington. Annual Report of the Director of the Department of Terrestrial Magnetism. (Reprinted from Year Book No. 27, for the year 1927-28.) Pp. 203-267. (Washington, D.C.)

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. Second Series (Geology), Vol. 12, No. 1. Pp. 152+23 plates. (Tôkyô and Sendai: Maruzen Co., Ltd.)

Proceedings of the United States National Museum. Vol 74, Art. 18: Bathnopterus, a new Fossil Gasteropod Genus from the Silurian of Alaska. By Edwin Kirk. (No. 2763.) Pp. 4+1 plate. (Washington, D.C.: Government Printing Office.)

Proceedings of the California Academy of Sciences. Vol. 18, No. 1: A new Species of Corambe from the Pacific Coast of North America. By Frank M. Macfarland and Charles H. O'Donoghue. Pp 27+3 plates. Vol 18, No. 2: A new Bird Family (Geospizidae) from the Galapagos Islands. By Harry S. Swarth. Pp. 29-43. Vol. 18, No 3: A Contribution to our Knowledge of the Nesting Habits of the Golden Eagle. By Joseph R Slevin. Pp 45-71+plates 4-7. (San Francisco, Calif.)

Journal of the Faculty of Science, Imperial University of Tokyo. Section 1: Mathematics, Astronomy, Physics, Chemistry. Vol. 1, Part 11. Pp. 417-437 0.60 yen. Section 2: Geology, Mineralogy, Geography, Seismology. Vol. 2, Part 7. Pp. 331-362+plates 66-69. 1.00 yen. Section 4. Zoology. Vol. 2, Part 1. Pp 49+8 plates. 1.70 yen. (Tokyo: Maruzen Co., Ltd.)

Proceedings of the American Academy of Arts and Sciences. Vol. 63, No. 5: A new Equation of State for Fluids. By James A. Beattie and Oscar C. Bridgeman. Pp. 229-308. 1.45 dollars. Vol. 63, No. 6. The Electrical Resistance of Alloys under Pressure By C. W. Ufford. Pp. 309-328. 60 cents Vol 63, No 7: The Effect of Pressure on the Resistance of Three Series of Alloys. By P. W. Bridgman. Pp 329-345. 45 cents. Vol. 63, No 8: The Compressibility and Pressure Coefficient of Resistance of Zirconium and Hafnium. By P. W. Bridgman. Pp. 347-350. 35 cents. (Boston, Mass.)

Rendiconti del Seminario Matematico e Fisico di Milano. Vol. 2 (1928—VI). Pp. xii+200. (Milano.)

Journal of the Faculty of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 24, Part 2: Influence of Ultra-violet Ray upon the Milking Cow. By Kenzo Iguchi and Kentaro Mitamura. Pp. 39-60. (Tokyo: Maruzen Co., Ltd.)

Department of the Interior. Bureau of Education. Bulletin, 1928, No. 15: Educational Achievements of One-Teacher and of larger Rural Schools. By Timon Covert. Pp. v+23. (Washington, D.C.: Government Printing Office.) 5 cents.

Proceedings of the United States National Museum. Vol. 74, Art. 22: Two new Frogs from Jamaica. By Emmett Reid Dunn. (No. 2767.) Pp. 2. (Washington, D.C.: Government Printing Office.)

Calendario del Santuario e delle Opere di Beneficenza Cristiana di Pompei, 1929. Pp. 256+32. (Pompei.)

CATALOGUES.

Entomologia (Neue Werke). No. 74. Pp. 56. (Berlin: W. Junk.)

A Rough List of Recent Purchases of Valuable Books on Zoology, Botany, the Physical and Mathematical Sciences, Sport, etc (New Series, No. 22.) Second Portion. Pp. 61-108. (London: Wheldon and Wesley, Ltd.)

Engineering and Industrial Instruments. (List E5.) Pp. 460. (London: Negretti and Zambra.)

Books and Measures for the Timber, Plywood, Pulp, Paper, Cabinet and Furniture and Woodwork Trades. Pp. 16. (London. Stobart and Son.)

Diary of Societies.

FRIDAY, MARCH 22.

INSTITUTION OF NAVAL ARCHITECTS (Annual Meeting) (at Royal Society of Arts), at 11.—Eng. Rear-Admiral W. Scott-Hill: Powdered Coal for Ships. —A. Spyer: Modern Developments of the Water Tube Boiler for Marine Purposes.—Eng. Rear-Admiral A. E. Hyne: Suggested Modifications to Marine Water Tube Boilers.—At 3.—J. Rennie Barnett: Motor Life-Boats of the Royal National Life-Boat Institution.

TEXTILE INSTITUTE (Lancashire Section) (at Manchester), at 1.15.—J. W. Cooling: Air Conditioning Apparatus, including Humidifying and De-Humidifying.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates' and Students' Section) (Newcastle-upon-Tyne), at 2.30.— J. T. Whetton: The Optics of Surveying Instruments and Tacheometric Surveying.—Paper open for further discussion:—The Lubrication of Colliery Coal Tubs, by L. H. Forster.

ROYAL SOCIETY FOR THE PROTECTION OF BIRDS (Annual Meeting) (at Middlesex Guildhall, Westminster), at 3.—Col. Sir George Courthope, Bart.: The Economic Value of Wild Birds.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section) (Clinical Meeting at Royal Free Hospital), at 4.30.

PHYSICAL SOCIETY (Annual General Meeting) (at Imperial College of Science), at 5.—Dr. W. H. Eccles: Presidential Address.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration on the Nerve Supply and Movements of the Colon.

INSTITUTION OF CIVIL ENGINEERS (Birmingham and District Association) (at Chamber of Commerce, Birmingham), at 6.—A. Page: The Development of the Generation and Distribution of Electricity in the British Isles.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—Annual General Meeting.

INSTITUTION OF LOCOMOTIVE ENGINEERS (North-Eastern Centre) (at Hotel Metropole, Leeds), at 7.—T. Robson: Experiments on Buffer Springs.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. Lambert: Warm Tones on Chloro-Bromide Papers.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE (Annual General Meeting) (at Royal Technical College, Glasgow), at 7.—F. G. Martin: Elastic Limit Steel.

BLACKBURN TEXTILE SOCIETY (at Blackburn Technical College), at 7.30 — A J. Hall: The Dyeing and Finishing of Cotton Piece Goods containing Artificial Silk

LEICESTER TEXTILE SOCIETY (at Victoria Hall, Leicester), at 7.30.— S. Kershaw: Faults in Yarns.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.— D. A. Collin: Ventilation.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Ernest Rutherford: Penetrating Radiations.

SATURDAY, MARCH 23.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Molecular Motions in Rarefied Gases (IV.).

MONDAY, MARCH 25.

INSTITUTION OF MECHANICAL ENGINEERS, at 6 30.—Wing-Comdr. T. R. Cave-Browne-Cave: Aircraft Engineering in its Relation to Mechanical Engineering (Annual Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—Hon. Sir Charles A. Parsons and J. Rosen: Direct Generation of Alternating Currents at High Voltages.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—J. Wright and C. W. Marshall: The Construction of the Grid Transmission System in Great Britain.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at Royal Technical College, Glasgow), at 7.30.—J. R. Campbell: The Activity of Various Catalysts in Promoting the Oxidation of Methane by Means of Oxygen. —W. J. Skilling and E. D. Ballantine: A Simple Method for the Determination of Phosphorus in Coal Ash.

HUNTERIAN SOCIETY OF LONDON, at 7 30.—Drs. H. Dally, E. Obermer, and T. Grey: Discussion on Blood Pressure in Health and Disease.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—C. H. Howkins: The Dental Aspects of Radium Treatment.—J. B. Parfitt: A Compound Composite Odontoma.

ROYAL GEOGRAPHICAL SOCIETY (at Polytechnic, Regent Street), at 8.30.— Sir Douglas Mawson: Recent Work on the Fjords of New Zealand.

MEDICAL SOCIETY OF LONDON, at 8.30—E. Holland, Dr. B. T. Parsons-Smith, and Dr. B. Hart: Medical Indications for the Induction of Abortion and Premature Labour.

TODMORDEN TEXTILE SOCIETY (at Todmorden).—Mr. Bentley: Cardroom Processes.

TUESDAY, MARCH 26.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Meeting), at 4.30.— H. Warington-Smyth: The Base Metal and Mineral Resources of South Africa.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. R. A. Young: A Medical Review of the Surgery of the Chest (Lumleian Lectures) (III.).

ROYAL AERONAUTICAL SOCIETY (at 7 Albemarle Street), at 5.30.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—B. L. Goodlet: The Testing of Porcelain Insulators.

ROYAL PHOTOGRAPHIC SOCIETY (Scientific and Technical Group) (Annual General Meeting), at 7.—Dr. F. C. Toy: "How it Works" in Photography.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—C. Lucas: The Nature of the Colour of Pottery, with Special Reference to that of Ancient Egypt.

MANCHESTER ATHENÆUM TEXTILE SOCIETY (at Manchester).—T. Hunt and Dr. E. R. Cooper. Life and Conditions in a Modern Spinning Mill.

WEDNESDAY, MARCH 27.

ROYAL SOCIETY OF MEDICINE (Comparative Medicine and Neurology Sections), at 5.—Special Discussion on Encephalo-myelitis of Man and Animals. I. A. Galloway (Comparative Medicine), Dr. J. G. Greenfield (Neurology). Other speakers: Dr. W. Russell Brain, Dr. T. Hare, L. P. Pugh, and others.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at 17 Fleet Street), at 5.30.—W. A. Benton. John Wyatt, and the Weighing of Heavy Loads.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.30.—D. H. Little: Roads.

ROYAL PHILOSOPHICAL SOCIETY OF GLASGOW (at 207 Bath Street, Glasgow), at 8.—Dr. F. Fergus: Vision and Industrial Efficiency.

INSTITUTE OF THE RUBBER INDUSTRY (at Glasgow).—Dr. Daynes: Methods and Appliances used in the Control of some Manufacturing Processes in the Rubber Industry.

PUBLIC LECTURE.

SATURDAY, MARCH 23.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—M. A. Phillips: Mammals of Britain.

SATURDAY, MARCH 30, 1929.

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Petrol.

THE problem of petrol arises in acute form once again, and the lay mind is finding it difficult to reconcile continually increasing production of crude oil with, apparently, a directly proportional rise in price of its most valuable derivative. As a purely economic consideration, petrol is not exactly a straightforward commodity to assess in terms of supply and demand, for the simple reason that this usually close relationship does not in this particular case express the condition of the oil industry at any time. When complicated by conflicting commercial and political issues, these confined to no one country, it is small wonder that a number of the less obvious controlling factors in the situation fail to be appreciated by the public at large.

From the technical aspect, the data of the problem are quite clear. Of a total world-production in 1928 of crude oil amounting to 182 million tons, the United States accounted for 127 millions, nearly 70 per cent; Venezuela, the next on the list, yielded 15 million tons, about 8 per cent; Russia contributed $11\frac{1}{2}$ million tons, or about 6 per cent; Mexico, $6\frac{1}{2}$ million tons, about 3 per cent; and Persia, the oil industry of which figures especially prominently in contemporary discussions in the British press, produced 5 million tons, or $2\frac{1}{2}$ per cent (the figures are approximate). Thus all the remaining countries combined account for only 10 per cent of the total output, and the United States persists as the dominating factor in the industry, so far as resources and exploitation are concerned. Incidentally, in spite of local 'proration' agreements, that country continues to flood the market with some 385,000 tons of crude oil per day, a steadily rising figure. Statistics can, of course, be made to prove practically anything, but a sense of proportion born of a grasp of these data is the first step in understanding the present petrol situation.

So many tons of crude oil output, however, do not constitute the barometer of the industry. As E. H. Davenport has recently shown in a pamphlet entitled "The Price of Petrol" (London General Press), in order to appreciate the true economic position, the supply-demand relationship of other important derivatives of crude oil must be ascertained, since petrol is only one of a series of vital products to modern civilisation.

Now excluding paraffin and lubricants, fuel-oil, a heavy residuum from crude oil distillation, has its own particular scheme of economics. Apart

from its enhanced use as a basis of 'cracked' derivatives; it is essentially this oil of which we hear so much in competition with coal. By no means an unimportant influence in the present petrol 'crisis' is this very item fuel-oil, the market vicissitudes of which operate directly in response to fluctuations of coal supply and demand. There is a great deal of nonsense written about the antagonistic purposes of oil and coal, but one thing is abundantly clear: the two commodities, in so far as supply and demand are concerned, are as sensitively balanced in the world of fuel as any delicately poised beam in a laboratory.

If for any reason fuel-oil receipts drop in favour of other forms of thermal energy, the deficit must be spread throughout the oil industry as a whole. Since petrol is the most thriving product of all for which that industry is responsible, it must perforce shoulder its share—a lion's share at that—of the burden. This means that the net profits on the sale of petrol tend to be lessened periodically by a fluctuating amount. Since the oil companies with all their faults are at least financially sane, and realise better than anyone else what is the economic minimum at which petrol may be retailed to show a working profit *on the total cost of their complete operations*, not being philanthropists, they have perforce to pass on such fluctuations, either plus or minus, to the consumer; the latter is, after all, the only possible individual who can harmonise the contending factors. But this is only one other aspect of the matter.

Whatever may or may not be the wisdom of amalgamations or 'combines' as they have come to be known, monopoly, if this be implied and providing it be not abused, can operate in favour of the public by supplying standard commodities at standard or at least economic prices. Any undercutting of such prices as may ensue, unless backed by resources constituting a serious menace to the major interests, will be local and short-lived. The public gains a penny here and there, but is soon forced back to acceptance of 'combine' prices, either through restricted operations of the external interests involved, or through ultimate failure of the latter to contest the market. Should there be, however, a definite attempt at breaking monopoly by prolonged attack, supported by the formidable weapons of large resources of equally high quality products, then competition runs keenly and the public is undoubtedly the gainer during the phase of severe price-cutting which ensues.

If during this period natural resources were for any reason to decline, a truce might automatically be called; but if, as is the actual case, resources increase at a rate which definitely establishes supply in excess of demand, then sooner or later the position has to be faced by the contending parties which, put briefly, means compromise or bankruptcy. There must always be an economic limit, especially in petroleum undertakings, below which it pays no one to produce and distribute petrol, or any other commodity for that matter. In the present circumstances, both competition, heavily backed by adequate resources, and over-production have helped to bring about the logical situation now being faced by producer and consumer.

The recent increase in price of petrol in Great Britain is not an impetuous act of economic or political spite. Its incidence is a direct outcome of a chain of circumstances the operation of which has all along been perfectly clear to the intelligent observer who is not content to accept at face-value *ex-parte* statements in the daily press.

The immediate post-War price of petrol was, of course, excessive, but rendered inevitable by the difficult conditions of restabilisation of international trade, in which petroleum played no unimportant part. This price, however, did not last long, for despite an enormously increased demand for petrol since 1920, supplies more than kept pace, due not so much to over-production of crude oil, but, as Davenport points out, to the economic operation of 'cracking' in refinery process. Thus, applied science has had a direct hand in price-control, for perfection of cracking plants has led to considerably enhanced petrol yield per barrel of oil run to the stills, apart from influencing paraffin production, etc. Hence the principal organisations responsible for producing and marketing petrol were able to take full advantage of public demand, and to hand on to the consumer a small share—in the shape of decreased price per gallon—of the success they were enjoying.

Then came, as it was bound to do, the Russian entry into the market. To understand the full significance of this incursion, it should be recognised that, apart from any commercial or political prejudice, petroleum emanating from the Russian fields is, technically speaking, of exceptionally high quality, a fact well known from the earliest days of the oil industry. While this statement in no sense implies inferiority of competitive oils or products, the temporary exclusion of this fuel from European markets was something of a calamity. Nothing but abundant resources and sound refining values could have re-established so quickly Russian oil in the world's markets, to the

extent of constituting that country the third most important producer last year. Whatever may be the ethics of the case, there has been an undoubted demand for Russian oil in Great Britain during the last few years, a demand which, in its growth, has forced the very issue to which we have referred. A measure of the economic situation created in 1928 is to be found in the price of petrol in London prior to Government tax: 1*s.* 0½*d.* per gallon (ex pump). Anyone, even with the slightest knowledge of the technical side of the oil industry, knows that such a price is unsound and can never bear a proper ratio to capital outlay and cost of production, especially when it is remembered that from that figure transport charges and retailer's commission must be deducted before the producer can reckon his profit. Consequently, things were destined to alter in any case, and compromise between conflicting interests was an inevitable policy foreseen long before the *fait accompli* was realised. The natural corollary to such compromise is the raising of the price of petrol to an acceptable economic minimum.

In the meantime, however, the Government made an imposition of 4*d.* tax per gallon of petrol last year, to which the retailer added ¼*d.* as cost of collection. Thus in London the price of petrol rose to 1*s.* 4¾*d.* ex pump, or 1*s.* 5¾*d.* (or more) in the provinces. This, however, had nothing to do with the economic situation in the industry, though it may since have had some slight repercussion in the matter of decreased demand. The price of petrol at the round figure of 1*s.* 5*d.* or 1*s.* 6*d.*, though possibly distasteful to the consumer, clearly left the main problem of economic minimum unaffected, and something was bound to happen to alter these conditions from the point of view of the well-being of the industry as a whole. The plain fact is that, until the recent increment of 2¼*d.* per gallon was made by the industry on Mar. 1, nothing had occurred to alleviate the serious position of a year ago; the addition of this increment is an expression of compromise between contending interests, or, in the absence of any specific agreement at the moment, it is a measure of consolidation of the inevitable position which the industry must take up to 'put its own house in order' whatever may fall in the future. Even now, it should be noted, the increase only brings the total price of petrol to 1*s.* 2¾*d.* per gallon excluding tax: it remains to be seen for how long that price will be considered adequate to the needs of a complex industry.

Petroleum, once exploited, is a wasting asset. In the face of production on a scale never before achieved or even contemplated, it is difficult to forecast events; but anything which tends to promote its economic production and utilisation may be construed as a measure of conservation, and this care it is the duty of the industry to foster. If enhanced price of petrol is economically justified, as we believe it to be, then it will have the effect of strengthening the industry in a determination to prevent waste of this valuable commodity at all costs. To this extent recent events have perhaps been beneficial.

H. B. M.

Practical Oceanography.

Science of the Sea: an Elementary Handbook of Practical Oceanography for Travellers, Sailors, and Yachtsmen. Prepared by The Challenger Society for the Promotion of the Study of Oceanography. Originally edited by Dr. G. Herbert Fowler. Second edition, edited by Dr. E. J. Allen. Pp. xxiii + 502. (Oxford: Clarendon Press; London: Oxford University Press, 1928.) 15*s.* net.

The Challenger Society has done well in issuing a new and revised edition of this well-known and useful book, which has been out-of-print for some years, and the new editor, Dr. E. J. Allen, is to be congratulated on having retained the original character of the work, while bringing it abreast of modern progress. Oceanography has advanced in several directions since the War, and its progress has been due in no small measure to British work, though we have had no great oceanographical expedition devoted purely to such problems, as the Germans have had in the *Meteor* expedition. One would like to see Britain again taking the lead in great oceanographical explorations, as befits her position as the greatest seafaring nation. Much of interest will no doubt come of the *Discovery* expedition, but this is necessarily tied down somewhat strictly to the investigation of the very pressing economic problems arising out of the exploitation of whaling. May the "Science of the Sea" help in stimulating that interest in the problems of the ocean which is dormant in the heart of every Briton, and bring the time nearer when the purse-strings will be loosened to enable Britain take her rightful part in oceanographical exploration.

The book is addressed primarily to "travellers, sailors, and yachtsmen," to all those whom business or pleasure takes upon the great oceans, and it will prove of inestimable service to all such who wish

to take part, in however modest a fashion, in the study of marine problems. To those who ask, "What can I do for oceanography?" this book supplies a sufficient and thoroughly practical answer. It will be of interest also to others, to those who have no opportunity to do work at sea, but wish to learn about oceanographical problems and the methods by which they are studied. Also, the student who is beginning to take up marine or fishery work will profit greatly by a careful reading of this book, which has the great advantage of being written throughout by practical workers of long experience and proved competence.

As we have said, the volume follows fairly closely the arrangement adopted in the original edition, and certain sections show little change, though all have been revised. The chapters on the air and water have been completely re-written, the former by Capt. Brunt and Comdr. Garbett, the superintendents respectively of the Army and Navy Meteorological Services of the Air Ministry, the latter by Mr. D. J. Matthews and Dr. W. R. G. Atkins. Both chapters are extremely well done. Dr. Atkins's contribution deals with the alkalinity of sea water, and gives a full account—perhaps just a little difficult for the beginner—of the methods to be employed in determining the pH of sea water. Mr. Matthews describes in outline the main current systems of the oceans, and gives eminently practical instructions for the use of hydrographical instruments and methods. It might have been well to mention Lumby's surface sampler, which makes the collection of water samples from vessels under way much easier and more satisfactory than the old bucket method. The definitive description of this instrument has, however, only just recently been published (*Jour. du Conseil*, **3**, 3; 1928). An interesting comment is made by Matthews on the echo-sounding method of determining depths. He rightly fears that the spread of this most valuable method will result in a serious decrease in the number of bottom temperatures and samples of bottom deposits collected.

In the biological sections there is apparent a certain inequality of treatment—the fixed plants, for example, are dealt with in a very adequate manner by Mrs. Weber van Bosse, while the fishes receive much less space. But one must admit that to treat of the fishes in a comprehensive way would have taken up practically the whole volume. The section on phytoplankton, by Dr. Marie Lebour, is new, and, though short, is admirably done. Prof. Stanley Gardiner has re-written his fascinating and practical account of tropical shore-collecting, and the section on fishing gear has been considerably strengthened. Of great practical value is the chapter on the preservation of marine animals, by Dr. Allen and Mr. E. T. Browne—a subject on which expert advice is always welcome. Prof. D'Arcy Thompson's charmingly written account of whales and seals—and sea-serpents—will be of especial value to the ocean traveller.

The illustrations are on the whole good, with the exception of some of the small figures of plankton and benthonic animals. The useful appendices of the original edition are retained and expanded—a list of marine stations, of literature, of recommended firms for the supply of apparatus, and an outline biological classification. The list of literature might have been extended with advantage. One notes with interest and some surprise that the number of marine stations listed, in all parts of the world, amounts to more than one hundred. The frontispiece is, most appropriately, a portrait of the late Sir John Murray, to whom the science of the sea owes so much.

Colliery Economics.

The Economics of Coal Mining. By Prof. Robert W. Dron. Pp. vii+168. (London: Edward Arnold and Co., 1928.) 10*s.* 6*d.* net.

THE subject of the above work is one of the greatest possible importance at the present moment when coal mining problems bulk so largely in the public interest. Prof. Dron has produced a very readable and very useful little book in which most of the problems connected with the economics of coal mining are succinctly reviewed. It comprises ten chapters: namely, an introductory chapter, one devoted to mineral leases, two to valuations, the first of these referring to the valuation of a mineral property and the second to the valuation of an operating colliery; another chapter considers the economics of the development of a new undertaking; another gives estimates of capital expenditure, another the cost of power production, whilst the final chapters are devoted to the organisation of a colliery, to coal cleaning, and to legal considerations, the latter being devoted mainly to the questions of subsidence and trespass.

As might be expected from a colliery engineer of Prof. Dron's knowledge and experience, the work is throughout of a high order; since, however, a large number of the questions treated of are of a distinctly controversial nature, few mining engineers

will be found to agree with all Prof. Dron's views, though a large majority of them will agree with the greater portion thereof.

When critically examined, the chapters on valuation are probably the weakest in the book, and give evidence of less clear thinking on this important subject than might perhaps have been expected from the author. Thus, in the chapter dealing with the valuation of mineral properties, the author introduces a consideration of the costs of mining operations ; such costs have, however, nothing at all to do with the case, because the value of a mineral property is determined solely by the consideration of the income which this property would yield and, therefore, the capitalised value of the mineral royalties. In a previous chapter the author has considered the true meaning of royalty and quite correctly distinguishes between it and an occupation rent, and quotes the authoritative statement on the subject from the Report of the Royal Commission on the Coal Industry (1925), which shows that "a rent is paid for the use of a thing which endures," whilst "a mineral royalty is paid for the purchase of the thing itself."

Prof. Dron is, however, in error when he considers that the word royalty is a survival from Queen Elizabeth's time. The word was never used in this modern sense by medieval writers, and, in fact, its first use in this particular sense appears to date from the first half of the nineteenth century. Prof. Dron refers correctly enough to the decision about the year 1568, which assigned all mines except royal mines to the owners of the land in which they occur, but he omits to point out that the Crown never at any time even claimed the ownership of or a royalty in respect of coal. The distinction is sufficiently important for Prof. Dron to have directed attention to it. It may also be suggested that the Scotch term 'lordship,' which is the Scotch equivalent of royalty, should not be used without defining it for English readers.

Prof. Dron has fallen into a curious arithmetical blunder in his footnote to p. 31 in discussing the local rates payable by mineral owners in Scotland. He states quite correctly that in Scotland the local rates on a colliery are payable approximately one-half by the owner and one-half by the lessee, but goes on to say that in England and Wales, "so far as the writer is aware, no part of the local rates is paid by the mineral owner." Prof. Dron's statement on the latter point should have been much more definite, and he appears to be unaware of the reason for this difference ; in England and Wales the fixing of rates is based upon the well-known statute of Queen Elizabeth's time, which enacts that rates may be levied upon every occupier of coal mines, etc. ; this statute has since been greatly extended and modified and other rates have been added, but the basal principle that the occupier is liable for the rates has never been altered.

In Scotland, on the other hand, the fundamental legislation which controls rating is contained in an Act of Queen Victoria's time passed in 1854 ; and although the general principle laid down in that Act is varied to some extent by the local Acts, its general effect remains, so that approximately one half of the rates is paid by the owners of the mine and the other half by the occupiers. The reason for the difference in treatment of mine owners in Scotland and England is thus quite clear.

Prof. Dron's error, which has been referred to above, is in his calculation of the amount of the local rates payable by mineral owners, which he states "is equal to about 1*s*. 6*d*. per ton of output." He bases this on his statement that the local rates payable by mineral owners in 1925 were about £230,000 per annum. He has previously given the output for that year as 28,394,000 tons (a clerical error in the table on pp. 10 and 11 would make this about 28,000 million tons, but this error does not affect the case.) A simple calculation will show that the rate above given amounts not to 1*s*. 6*d*. per ton but to nearly 2*d*. per ton, and it can only be surmised that Prof. Dron has carelessly misplaced a decimal point. Such an error is a comparatively venial one, but in the present instance would lead to important results. Prof. Dron has no doubt a long and varied experience in dealing with Scottish mineral owners, but it may gravely be doubted whether he has come across one so constituted as to be willing to accept 6*d*. per ton in payment for his coal and pay out in return 1*s*. 6*d*. per ton for his rates. Scotch mineral owners are not usually credited with such a degree of quixotic altruism or such utter carelessness to their own interests as a bargain on Prof. Dron's lines would appear to indicate, and it is incomprehensible why this fact should not have struck him whilst he was writing the lines in question.

It may also be asked what Prof. Dron means by stating that his chapter on the valuation of minerals is devoted to the simplest case, namely, "the valuation of minerals in actual course of working," and a few lines further down to discuss such a valuation in the case "if the winding pits are not established on the property under investigation." It

would be interesting to know how the mine could be in the course of working before the winding pits are sunk.

In his next chapter, on the valuation of a going colliery, Prof. Dron commits an error into which very many, perhaps the majority, of mining engineers are apt to fall. He tabulates for a valuation of a colliery the estimated future output and the life of the coalfield; in other words, he commences by stating what the quantity of coal is which the field in question contains. This is a fact that neither he nor anyone else can know in advance; he might be entitled to state that the field is estimated to contain a certain quantity of coal, though the more correct statement would be that the most probable quantity of coal contained in the field is so much, the most probable quantity being that which is as likely to be exceeded as to be fallen short of when the coal comes to be actually worked. Until it is worked, no one can say how much the field actually contains.

Prof. Dron deals very briefly with the problem of deferred royalties, and it seems evident that he has not seen the elaborate discussion of the subject in a paper on "The Value of a Deferred Annuity, with Special Reference to the Valuation of a Mineral Property," by Charlton Carpmael (*Jour. Inst. Actuaries*, vol. 56, pp. 25-72; 1925).

In conclusion, it may be said that the chapters here selected for detailed criticism are on a subject which is perhaps the most difficult and the most controversial of any in the book; and the fact that different views are here put forward on many points to those advanced by the author must not be taken as any indication that the book is not an exceedingly valuable one; indeed, it is likely to be of the utmost use to all colliery engineers.

British Sea Anemones.

The British Sea Anemones. By Dr. T. A. Stephenson. Vol. 1. (Ray Society Volume No. 113.) Pp. xiv + 148 + 14 plates. (London: Dulau and Co., Ltd., 1928.)

WHILST in some branches of science, especially physics, there are so many workers in the field that monographs can be continually revised, in others many years must pass by before an expert can bring our knowledge up-to-date. Dr. T. A. Stephenson, one of the two leading workers on anemones at the present time, is to be congratulated on his effort to bring together and set in order the facts known about British sea anemones, their structure, development, bionomics, and classification. It is the first successful attempt to supplement the famous work of Gosse completed so long ago as 1860, when the comparative anatomy of anemones had not been studied.

It will perhaps be a disappointment to some who have looked forward to the appearance of this important work that the body of it is apparently being held back for a subsequent volume. Although the author lays stress on the fact that for the purposes of the monograph a clear understanding of anatomy is necessary, it is doubtful whether the general reader will feel urged to read through the technical and well-illustrated section on structure, which occupies the greater part of the text, until the appearance of the next volume: this will presumably contain descriptions of the species. But the remaining sections, particularly that on bionomics, are full of absorbing interest.

The author describes the different haunts of these animals; and points out where the best collecting grounds are, and which species can best be maintained in aquaria. Interesting notes are given of the rapid way in which some anemones can move about, of how they capture and digest their food, and, above all, of the various methods of reproduction, even at the mature age of three score years and ten. He instances one anemone which, as soon as it begins to rove about, leaves behind pieces of its base, which, retaining hold of the substratum, regenerate into normal individuals. True budding is not a characteristic of these animals, the total absence of colonialism and skeleton building being correlated with a relatively active habit. Their ancestors were probably creeping, bilaterally symmetrical forms, and radial symmetry supervened when a more sedentary life was adopted.

Dr. Stephenson is an artist of no mean order, and has drawn a number of beautiful and convincing studies of living anemones. He is careful to explain, however, that individuals can look quite unlike the portraits given of their particular species, and that his illustrations necessarily represent fleeting aspects of selected colour varieties of most changeable organisms. He goes into the questions of coloration and pattern, and the methods of collecting and maintaining anemones in aquaria. Notes are given on natural enemies and messmates. The author mentions their use for fishermen's bait, and that they form a considerable part of the diet of some fish like cod, whiting, haddock, and especially flounders. A long list of works on anemones is given, and the reader is shown where to look for information under various sub-headings.

A. K. Totton.

Our Bookshelf.

The Yearbook of the Universities of the Empire, 1929. Edited by T. S. Sterling. Published for the Universities Bureau of the British Empire. Pp. xiv + 852. (London: G. Bell and Sons, Ltd., 1929.) 7*s*. 6*d*. net.

IN pre-War days, "Minerva" was the standard reference book of the personnel of the universities and learned bodies of the world. After a lean period, it has regained its position, but at the cost of growth to three very bulky volumes. The "Universities Yearbook" covers the universities of the British Empire and is a compact handbook of less than a thousand pages; its data, being compiled from university calendars and similar official publications, is thus trustworthy.

The "Yearbook" is divided into sections dealing with Great Britain and Ireland, Canada, Australia, South Africa, and India respectively. Each section is preceded by a brief account of the history and the regulations of the universities of the section, after which each university is dealt with separately. A directory of the staff, arranged under departments, is given, followed by general information, including equipment of laboratories, museums, etc., degrees, residential accommodation, changes of staff during the past year, student statistics, and so on.

The appendices occupy about a third of the book and provide most valuable information, which is only available elsewhere in widely scattered publications. They cover the regulations for professional bodies, matriculation examinations, inter-university scholarships and grants for research, professional schools of the universities, and the distribution of subjects in which various universities specialise, centres of research outside the universities, and titles of theses accepted for research doctorates. There are name and general indexes.

We commend the book to all who wish for information on educational facilities of university standing. For ourselves, there are few reference books to which we turn more frequently or with more confidence.

The Symmetrical Optical System. By Dr. G. C. Steward. (Cambridge Tracts in Mathematics and Mathematical Physics, No. 25.) Pp. viii + 102. (Cambridge: At the University Press, 1928.) 7*s*. 6*d*. net.

THIS is the latest addition to the useful series of Cambridge Tracts in Mathematics and Mathematical Physics. It enlarges upon the short section devoted to the characteristic function in the earlier book of the same series ("The Elementary Theory of the Symmetrical Optical Instrument," by J. G. Leatham), by an early use of the functions of Hamilton and Bruns. The author has made a welcome departure from the purely geometrical discussion in calculating the distribution of energy in diffraction patterns associated with the primary aberrations, a purpose for which treatments based upon the principle of optical path are naturally convenient. It is to be hoped that the end of optics completely divorced from practice has at last arrived. Had the developments made by the author and Mr. T. Smith been only a little earlier, the subject of geometrical optics might still have been included in the Tripos.

It might be suggested that the heading of Chapter v., "The Computation of Optical Systems," is a little misleading. The chapter deals with the computation of aberration of optical systems, and not with the design of systems, as the heading might lead one to suspect.

The book is, of course, addressed only to readers with the requisite mathematical equipment. Those without such an equipment can obtain many of the same results by other means.

The Story of the American Indian. By Prof. Paul Radin. Pp. xiv + 371 + 30 plates. (London: John Murray, n.d.) 21*s*. net.

IN the story of the American Indian, Dr. Radin traces the spread of offshoots of the elaborate Maya civilisation over a great part of North America. There was, according to him, one stream of an early stage of Mayan culture that evidently went by sea to the mouth of the Mississippi, spread mainly northwards to found the culture of the Mound-builders, and underwent transformation as it proceeded; eventually these immigrants were overwhelmed by the simpler peoples around them. Certain cultural traits spread over the plains, weakening as they reached the north-eastern woodlands. Another stream (of Toltec culture) flowed into Arizona and New Mexico, where it overlaid an older Mayan layer that had spread from the east; this culture was partially assimilated by the Navaho, Pawnee, and others. The capitalists of the north-west coast have closer affinities with Asia and striking resemblances to conditions met with in Melanesia. The high pre-Inca cultures of Peru are discussed in a similar way.

Dr. Radin traces these connexions in an interesting manner. The book should not be overlooked by ethnologists, but being innocent of references and an index, it is apparently written for non-specialist readers.

Lehrbuch der anorganischen Chemie. Von Karl A. Hofmann. Sechste Auflage. Pp. xv + 784 + 7 Tafeln. (Braunschweig: Friedr. Vieweg und Sohn A.-G., 1928.) 20 gold marks.

THE sixth edition of Prof. Hofmann's "Lehrbuch" follows the preceding edition after an interval of three and a half years. No drastic alterations have been made, but an important chapter of twenty-three pages has been added on the organometallic compounds. This is included in a part of the volume which contains chapters on explosives, structure of inorganic compounds, structure of crystals, radioactivity, and atomic structure. Those who are not acquainted with the book may therefore be assured that it deals as adequately with general questions as it does with the properties of individual elements and compounds.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Excitation of Mercury Vapour by the Resonance Line.

THE early researches of R. W. Wood (1912) showed that mercury excited by the light of the line 2537 emitted resonance radiation of the same frequency as the absorbed light.

Accompanying this resonance radiation there is radiation of longer wave-length, comprised chiefly in two broad maxima, one about λ3300, and the other giving rise to visual green fluorescence. These last radiations, which are regarded as of molecular origin, appear at higher vapour densities than are required for the resonance radiation, which has always been regarded as a purely atomic phenomenon.

F. S. Phillips in 1913 showed that the visual luminosity could be caused to move away from the place of origin if the vapour was in rapid motion. Photographing the spectrum, he concluded that the ultra-violet radiation around λ3300 and the line 2537 could also be detected in the vapour stream away from the place of origin.

I have always been puzzled by these phenomena, and the mystery has not seemed at all less since observing (see NATURE, Nov. 10, 1928) that the visible radiation could be produced by excitation lower than the resonance line, and that in this case too the secondary source was capable of being blown away from the place of excitation.

The question arises: What is the relation between the 2537 radiation and the visual radiation in Phillips's experiment ?

Although not yet prepared with a complete answer, I wish to describe some experimental results which analyse the phenomenon more closely than has yet been done.

The distillation may be carried out *in vacuo*, or with a moderate air pressure in the condenser, which results in a more dense but less rapid vapour stream. The added air does not mix with the mercury vapour under these conditions until the condenser is reached.

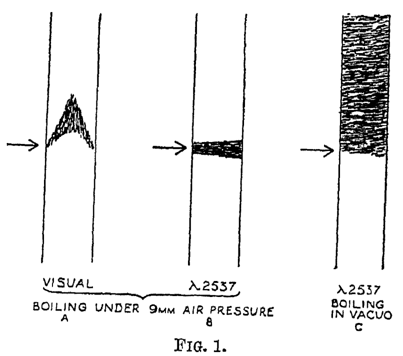

FIG. 1.

Distilling the vapour up a silica tube 1·5 cm. square section, with an air pressure of 9 mm. in the condenser, the visual glow is of the shape shown in Fig. 1A, the arrow indicating the direction of the narrow incident beam. The arched form indicates, as Wood and Pienkowski have shown, that after excitation there is a time lag before the luminosity sets in. This is most apparent in the middle of the tube, where the stream is most rapid.

On the other hand, the re-emitted ultra-violet radiation comes laterally from the cone marked out by the incident rays, undeflected by the vapour current (see Fig. 1B). This appearance is obtained by photographing through filters of chlorine and bromine in series, which transmit the line 2537 but cut out the less refrangible radiations.

Finally, on making the vapour current more rapid by completely exhausting the condenser, the visual radiation is thinned out to vanishing point, and the source of 2537 radiation moves up as well (see Fig. 1C). That this really is the radiation 2537 was checked by photographing through chlorine and bromine with addition of mercury vapour in an independent cell, of such thickness and density as to absorb about a breadth of 1 A. at this point without absorption at any other relevant part of the spectra. The luminosity in the tube was altogether cut out by this filter.

It seems therefore, so far as can be judged from the evidence yet available, that the 2537 radiation is simply Wood's resonance radiation, and that in the experiments with a blast of vapour its source can be observed as separated in space from the source of the continuous bands which are doubtless of molecular origin. But if this interpretation is accepted, the surprising thing is that the source of resonance radiation is in itself capable of moving considerable distances in a sufficiently rapid blast. This would show that the interval between excitation and emission is under some conditions enormously longer than the 10^{-7} seconds usually assigned. If so, many received views will need revision.

RAYLEIGH.

Terling Place, Chelmsford,
Mar. 14.

The Constitution of Oxygen.

W. F. GIAUQUE and H. L. Johnston in a recent letter (NATURE, Mar. 2, p. 318) state that certain observations on absorption bands are only explicable by the hypothesis that oxygen contains atoms of mass 18. Unfortunately, they do not give any indication at all of the abundance of these relative to the normal atoms.

So far as I am aware, there is no evidence obtained from positive ray analysis of any kind which would lead us to suppose oxygen other than a simple element. In my recent measurement of packing fractions the line due to O^{16} was taken as standard and, to take the cases in which the evidence is most trustworthy, the atomic weights of hydrogen, fluorine, and iodine determined in this way were found to agree with the accepted values to within one part in ten thousand. The latter are expressed in terms of the mean atomic weight of oxygen, so that this is very strong, though indirect, proof that if O^{18} exists it cannot be present even to the extent of one part in one thousand.

In order to obtain evidence of a more direct kind I have done two experiments, one with the O_2 line, the other with the H_2O line. In the first the discharge tube was run with oxygen giving a strong line O_2 at 32. Now if O^{18} exists, there would be a line due to the molecule $O^{16}O^{18}$ at 34 of a strength directly proportional to the quantity of O^{18} present. With half an hour exposure a barely visible effect at 34 was obtained. Its relative intensity was measured by photometry against other and very short exposures of line 32 and came out at 0·14 per cent. This very faint effect may, in my opinion, be due to traces of S^{34}.

In the second experiment water vapour was

employed, and the faint line at 20 compared with the strong one at 18 in the same way. Here the effect was rather greater, amounting to 0·32 per cent. In an apparatus to which air has to be frequently admitted, one would expect some effect due to A^{40++} and Ne^{20}, but I think in this case it is to be ascribed mainly to $Si^{28}C^{++}$. In any event, the presence of the line may be explained without recourse to an unknown body.

If it can be shown that the absorption band effects are compatible quantitatively with the presence of the hypothetical isotope in proportion less than one part in 500, the matter will require further investigation. Otherwise it seems more reasonable to seek for them an alternative explanation and continue for the present to regard oxygen as a simple element.

F. W. ASTON.

Cavendish Laboratory,
Cambridge, Mar. 15.

Tsetse Fly and Big Game.

REFERRING to an editorial entitled "A Threat to the Zululand Game Reserves" in NATURE of Nov. 24, 1928, whilst very much in sympathy with the object of this article in so far as it refers to preservation in reserves of the natural fauna of South Africa, I am led to express the opinion that certain of the statements made would be very difficult to substantiate on the basis of available scientific data.

The article gives the impression of having been written rather from a partisan point of view than from that of a detached scientific reviewer. The relation between certain species of tsetse fly and game is certainly a controversial subject, but it is considerably less so amongst those best acquainted with the tsetse-fly problem than some ardent advocates of indiscriminate game preservation would have the world believe. In any case one does not expect NATURE to ignore the views of the leading entomological investigators on such a question. I may also point out that the *Journal of the Society for the Preservation of the Fauna of the Empire* is scarcely the publication in which one would expect to find unbiased views on this subject.

Justification for my venturing to offer criticism is to be found in the fact that a misstatement is included concerning certain experiments stated to have been carried out in this Colony, and further in the fact that vigorous efforts are being made by my Government at the present time to arrest the spread of tsetse fly in certain areas through reduction and control of game.

The misstatement referred to is contained in the passage, "On the other hand, satisfactory and unobjectionable methods of extirpating the tsetse fly and reducing the incidence of nagana in domestic stock are known, as has been shown by experiments carried out in Southern Rhodesia, where the bush itself, the winter retreat of the tsetse fly, has been attacked." It is true that many years ago, impressed by the apparent segregation of *Glossina morsitans* in shady forest during the latter part of the dry season, I suggested that in some localities destruction of these haunts might prove a practical method of eliminating the fly. It is also true that some experiments along these lines have been attempted in the Colony. It is not, however, true that these experiments have revealed a "satisfactory and unobjectionable" method of extirpating tsetse fly. In the first place, they have never been pursued to a satisfactory conclusion, and in the second, it is more than doubtful if they can be described as "unobjectionable" either from the sentimental or practical point of view. Surely to the Nature lover large-scale destruction of many of the most conspicuous and beautiful representatives of the natural flora must be equally objectionable as destruction of the fauna. The game in any case is capable of more rapid recovery than the forest, providing, of course, that in neither case is reduction pursued to extermination. From the practical point of view there is, of course, no question concerning the objection to the destruction of useful timber.

Careful perusal of the article reveals the fact that the ultimate dependence on the game of such species of tsetse fly as *Glossina morsitans* and *G. pallidipes* is not actually called in question. I take it, therefore, that the main contention is that it is not possible or not practicable to reduce the game sufficiently to make conditions unsuited to the fly, and that attempts to do so may have untoward consequences.

With reference to the possibility of game extermination aggravating the trouble in respect to domestic animals, I may state that the experience in this Colony is that any developments of this nature following persecution of the game have been very limited and of a purely temporary nature. So far, the final event has been a marked improvement on the original position.

It is noted that no reference is made to the possibility of tsetse fly being scattered by other methods involving interference with conditions in a fly belt. Wholesale destruction of the forest in a fly belt in the Hartley district of this Colony in 1913 was certainly followed by the temporary appearance of trypanosomiasis farther afield than it had occurred for years, although the number of flies present was exceedingly small. Had this belt been heavily infested, it is at least possible that much more serious losses might have been sustained. The final event in this case was, however, also satisfactory.

With regard to the next sentence, justification appears to be lacking for the statement that "total extermination of all wild carriers of nagana which the policy demands if it is to be effective." On the contrary, experience in South Africa indicates that total extermination of game is by no means necessary to get rid of certain species of tsetse fly and the diseases they convey. The bibliography in Austen's "Monograph of the Tsetse Flies" contains notes of interest in this connexion. The late Mr. Claude Fuller has also collected a number of valuable records in the Transvaal. Dr. Schwetz has recently pointed out how tsetse fly has receded with the game around Elizabethville in the Katanga. There is a considerable amount of additional evidence in this Colony.

"It is believed that the segregation of game in reserves tends to keep the tsetse fly restricted to definite areas." Segregation of game presumably implies a game reserve surrounded by game-free country. Certainly, maintenance of a game reserve will not restrict the range of tsetse fly, if conditions are suited to its perpetuation outside the reserve. The inhibiting factor would, therefore, be found in surrounding conditions, not the reserve itself. The suggestion that it is possible to reduce the game sufficiently around a reserve to produce conditions unsuited to the fly appears scarcely in accord with what is apparently the main contention of the article.

The statement that "slaughter of big game . . . has not succeeded, and cannot succeed, in reducing the numbers of tsetse" is an assertion which ignores the whole record of tsetse fly in South Africa and the published work of investigators fully qualified to formulate an opinion on this subject. A good case can certainly be made out for the view that slaughter of big game has in the past succeeded very markedly not only in reducing the numbers of tsetse (*G. morsitans*

and *G. pallidipes*) but in eliminating these insects from considerable areas. It is also not difficult to offer a plausible explanation of how this slaughter, falling short of extermination, would tend to eradicate these flies. Whilst the case may not be considered absolutely proved, there is no justification whatsoever for unconditional denial of the possibility of controlling tsetse fly through the game, particularly in limited areas.

I have no intention of entering into the controversy as to whether the Zululand game reserve should be abolished or otherwise. My object is purely to deprecate the appearance in a leading article in NATURE of unqualified statements which are open to challenge, and the treatment of a scientific and economic problem from a less dispassionate point of view than readers of NATURE have learnt to expect.

RUPERT W. JACK
(Chief Entomologist).

Department of Agriculture,
Salisbury, Southern Rhodesia,
Feb. 4.

READERS of NATURE are familiar with the controversy which has raged round the question of coincident game and tsetse extermination, and the article referred to was obviously not a full summary of the divergent views, as was implied in the words "many competent observers hold," etc. It was meant to point to considerations which seemed to have been overlooked in the case of the Zululand Reserves. In view of the crude method of game extermination which has been widely advocated, it is regrettable that the experimental destruction of the segregation haunts of tsetse, which seems to have been based upon sound entomological observation, was not pursued to finality, as we had understood, especially as Mr. Jack admits that the less scientific wholesale destruction of a forest fly-belt had satisfactory results. The fact that some years ago "an ill-advised game drive [in the Zululand region to which the original article referred], by scattering animals over farms in the neighbourhood, undoubtedly led to the infection of the cattle of colonists by nagana and it is alleged that about 1000 head died," strongly suggests that segregation in the reserve area limited the incidence of the disease. Finally, Mr. Jack's own report of 1926 on the "Tsetse Fly in the Lomagundi District," largely quoted by the *Journal of the Society for the Preservation of the Fauna of the Empire* (1926), the impartiality of which he impugns, indicated, by its comparison between the anti-nagana results of present-day settlement and the pioneer settlements in South Africa, that the rapid retiral of big game, in fact its local extermination, and nothing short of that, was the predominant cause of the disappearance of tsetse.

THE WRITER OF THE ARTICLE.

Knock Ratings of Pure Hydrocarbons.

IN their letter on page 276 of NATURE of Feb. 23, Prof. Nash and Mr. Howes point out the value of unsaturated hydrocarbons in suppressing knocking. Their figures show that benzene and toluene, which for some time were considered the most effective anti-knock hydrocarbons, actually possess this property to a very much smaller extent than many unsaturated hydrocarbons, particularly in the aliphatic series. The statement that pseudocumene has pro-knock tendencies is, however, misleading, particularly as Edgar's octane (1 . 1 . 3-trimethylpentane) is referred to in the same paragraph as a valuable anti-knock. Pseudocumene may be pro-knock when compared with benzene, but it is certainly not pro-knock in the general meaning of the term. Compared with benzole in high concentrations, Edgar's octane is also pro-knock. The terms pro-knock and anti-knock are used rather loosely, and it must be remembered that they only have a definite meaning when a standard fuel is mentioned.

Although our own results for the hydrocarbons tested by Prof. Nash and Mr. Howes fall in approximately the same order, there is one very noticeable exception. We find that diamylene is not such a good anti-knock hydrocarbon as they indicate, and that it certainly is not better than the parent hydrocarbon, trimethylethylene, from which it is derived. If this were true, as Prof. Nash and Mr. Howes' figures indicate, it would then be desirable to polymerise the lower unsaturated hydrocarbons as Reiman does in the patent quoted, which would be contrary to all refining experience, in which it has always been found that the treatment of any unsaturated product involving polymerisation always reduces the anti-knock properties. Our own figures for diamylene prepared from trimethylethylene by polymerisation with sulphuric acid, and also for diamylene obtained by fractionating the high boiling hydrocarbons formed when commercial amyl alcohol is treated with zinc chloride, are much lower than those obtained for trimethylethylene in equivalent concentration. Furthermore, the fractions from the latter source boiling over the range containing the triamylenes after suitable purification, give even lower figures than those obtained for diamylene. This result was only to be expected.

AUDIBILITY TEST ON RICARDO E. 5 ENGINE.

	H.U.C.R.	Change in H.U.C.R.	*n*-Heptane-Benzene Equivalent. (By Volume.)	
			Per cent.	
Standard reference fuel . . .	6·3	. .	44·7	55·3
Trimethylethylene .	7·2	+ 0·9	29·7	70·3
Diamylene from trimethylethylene .	6·96	+ 0·66	32·3	67·7
Diamylene from coml. amyl alcohol .	6·90	+ 0·60	33·2	66·8
Triamylene b.p. 240°-250° C. . . .	6 56	+ 0·26	39·0	61·0

The substances were tested in 20 per cent (by weight) concentration in standard fuel. Every substance was tested over as wide a range of concentration as possible, partly to reduce experimental error, and also because the relation between concentration and anti-knock value is not necessarily linear. When comparing polymerides, it is of course essential to work in weight concentration, as polymerisation does not involve a change in weight but generally one of volume.

Results confirming the observation that polymerisation reduces the anti-knock value were also obtained for methyl*cyclo*hexene and its dimeride methyl*cyclo*-hexyl-methyl*cyclo*hexene.

AUDIBILITY TESTS ON RICARDO E. 5 ENGINE.

	H.U.C.R.	Change in H.U.C.R.	*n*-Heptane-Benzene Equivalent. (By Volume.)	
			Per cent.	
Standard reference fuel . . .	6·3	. .	44·7	55·3
Methyl*cyclo*hexene .	7·02	+ 0·72	31·7	68·3
Methyl*cyclo*hexyl-methyl*cyclo*hexene	6·50	+ 0·20	40·1	59·9

The substances were tested in 20 per cent concentration (by weight) in standard fuel.

While testing *cyclo*hexene a very interesting observation was made. It was found that the value in any definite concentration was determined by the history of the sample. For example, a sample which had been standing in the laboratory improved in anti-knock value when distilled over sodium. On exposure to light and air this value fell rapidly; another sample, stored in a brown bottle, did not deteriorate nearly so rapidly. Eventually this behaviour was traced to the presence of traces of *cyclo*hexene peroxide, which is readily formed under the conditions described (compare *J.A.C.S.*, **50**, 568; 1928). This peroxide appears to be quite stable in solution and to accumulate on storage. The following are the figures obtained:

AUDIBILITY AND BOUNCING PIN TESTS ON ARMSTRONG ENGINE.

		H.U.C.R.	Change in H U C.R.	*n*-Heptane-Benzene Equivalent. (By Volume)	
				Per cent.	
Standard reference fuel . .		5 6	..	44 7	55 3
*Cyclo*hexene:					
Refluxed 48 hours over sodium Maximum value	20% solution by weight.	6 25	+0·65	34 9	65 1
Exposed to light and air six months		5 46	−0·14	47 3	52·7
Stored in brown bottle in diffused light six months		6 07	+0 47	36 8	63·2

Not all unsaturated hydrocarbons, however, appear to form peroxides so readily; often, if they do, decomposition occurs with the deposition of gum. The sample of *cyclo*hexene left in the light for six months deposited no visible gum.

The importance of testing unsaturated hydrocarbons to make sure that no peroxides are present must be emphasised, as the values obtained may be erroneous if this precaution is not adopted. Rough analyses of the samples of *cyclo*hexene referred to above gave 0·2 gm. peroxide oxygen per litre for the sample left in the light, and 0·009 gm. per litre for the other sample. It is interesting to note that *cyclo*hexene in contact with air shows indications of the presence of peroxides after a short exposure to ultra-violet light.

The observations of Prof. Nash and Mr. Howes that the olefines, which are comparatively stable towards certain oxidising agents, are the most effective in suppressing knocking, agrees well with our own. In general, we have found that comparing isomerides, the more compact a hydrocarbon molecule is the greater is its tendency to suppress knocking. Thus trimethylethylene is better than pentene—2. This conclusion is in agreement with Dr. Edgar's observation with regard to the isomeric heptanes.

The effect of introducing a second double bond is interesting. Of the hydrocarbons examined, those containing conjugated double bonds (*e.g.* $\beta\gamma$ dimethylbutadiene, $\Delta^{1\,3}$ *cyclo*hexadiene and butadiene) have excellent anti-knock properties. A diolefine in which the double bonds are not conjugated (*e.g.* diallyl) does not possess particularly marked anti-knock properties. In this connexion the effect of introducing double bonds into a *cyclo*hexane ring is interesting.

The substances were tested in 20 per cent concentration by weight.

The difficulty of correlating engine tests with conventional formulæ at once becomes apparent.

Another point of interest is the effect of the side chain attached to a benzene ring. Although it is now well known that an increase in the length of the chain

AUDIBILITY TEST ON RICARDO E. 5 ENGINE.

	H U.C R	Change in H.U.C R.	*n*-Heptane-Benzene Equivalent. (By Volume.)	
			Per cent.	
Standard reference fuel . . .	6·3	..	..	..
*Cyclo*hexane . .	6·56	+0·26	39·0	61·0
*Cyclo*hexene . .	6 76	+0·46	35·4	64·6
$\Delta^{1\,3}$ *cyclo*hexadiene .	7·32	+1·02	28·7	71·3
Benzene . . .	6·57	+0 27	38·8	61·2

reduces the anti-knocking properties, the opposite effect is found with side chains attached to benzene rings. For example, toluene has greater knock-suppressing tendencies than benzene, ethylbenzene than toluene, and propylbenzene than ethylbenzene. Yet xylene is inferior to ethylbenzene as an anti-knock, and pseudocumene is stated to be similarly inferior to benzene. Any theory which can explain all these facts must of necessity be very elastic.

S. F. BIRCH.
R. STANSFIELD.

Anglo-Persian Oil Co., Ltd.,
Meadhurst Laboratories,
Sunbury-on-Thames,
Mar. 7.

Swirl Opalescence.

WHEN preparing the lecithin-cholesterol suspension required for the reaction of Murata (*Jap. Zeit. für Derm. u. Urol.*, **22**, No. 11; 1922; *Sci. Reports Japanese Gov. Inst. Infect. Dis.*, vol. 2; 1923), I noticed that the most effective suspension was one which was free from visible suspended particles when freshly prepared, though the converse—that any truly colloidal suspension was suitable—was not true. The author did not note the point among his elaborate directions. He directed that the suspension should be used after standing about twenty minutes. Since at the end of this time the suspension begins to show a faint nacreous opalescence which is not removed by filtration through ordinary filter-paper, it is possible that the reaction depends in some way upon a change of state from the truly colloidal to the condition of a coarse suspension. It may be remarked that for the Wassermann antigen containing the same components an approximately colloidal state is not requisite.

It is interesting to inquire upon what the property of swirl opalescence depends. The phenomenon is well shown by so-called gold paints and similar preparations, which are suspensions of small metallic flakes formed by stamping a suitable metal. Since these preparations show a high degree of swirl effect, it might be thought that a laminar structure of the suspended solid would be a necessary condition for the manifestation of the phenomenon. It is nevertheless difficult to demonstrate the effect well with aqueous suspensions of cholesterol, although the typical crystal of cholesterol is a lamina. Blood corpuscles in urine or isotonic saline show swirl opalescence, but to a smaller degree than does a suspension of coliform organisms. Suspensions of cocci do not show the phenomenon.

Since swirling produces a local orientation of liquid into parallel planes, swirl opalescence may be taken to result from locally regular reflection of light from particles in these planes. The particles must be

opaque, and good reflectors, or possess a refractive index differing sufficiently from the refractive index of the medium. Moreover, they must have at least one dimension considerable with respect to the other one or two dimensions, in order to provide the turning moment which shall set them finally along the plane of the stream. Thus the phenomenon may be shown not only by lamellar structures, but also by bacilli and acicular crystals.

Probably the best-known example of the phenomenon is afforded by a familiar brand of household ammonia, in which minute crystals of salts of the higher fatty acids are suspended. Microscopic examination shows that the crystals are acicular, or plumose. Suspensions of benzidine in very dilute alcohol show a high degree of opalescence. Commercial solid recrystallised benzidine appears laminar to the naked eye, and if it is dissolved in alcohol and allowed to evaporate, a mass of broad thin plates, often of considerable length, is seen. Support is thereby suggested for the presence of laminæ in its opalescent suspension, but further examination did not altogether confirm that theory.

A suspension was prepared by rapidly adding 0·5 c.c. of a hot 2 per cent alcoholic solution of benzidine to about 50 c.c. of water at room temperature. Microscopic examination on a slide without a cover-glass, of a drop of the suspension, showed a number of acicular crystals, with a larger proportion of almost circular, very thin, platelets. A film formed on the surface, and the film was almost entirely composed of aggregated platelets. When the drop was examined in a covered hæmocytometer chamber, acicular crystals preponderated: the platelets appeared to be the product of slow evaporation, and were the chief forms in a film which formed on the surface of the bulk of the suspension. Two other suspensions were prepared similarly, except that for one the water was warmed to about 30°, and the other was warmed to that temperature after addition of the benzidine solution. When these clear solutions had cooled they deposited crystals just visible to the naked eye, and the opalescence differed much in degree and kind from that of the unheated suspensions. Microscopic examination showed that the crystals were almost entirely lamellar agglutinations, which, probably owing to their extreme thinness, had far less effect in producing opalescence than had the acicular forms.

To the question why a definitely acicular crystal, such as lead iodide, does not give more than an incipient swirl opalescence, the reply may be suggested that it is partly because its high specific gravity favours rapid settling, and partly because the crystals are relatively large, that is, their number in a given volume is not great enough to enable them to reflect light with sufficient regularity. The relatively large lamellar particles of gold paints each reflect an appreciable amount of light, making up in surface what they lack in numbers.

Hugh Nicol.
Pathological Laboratory,
Hospital for Epilepsy and Paralysis,
Maida Vale, London, W.9.

Rigidity in Weak Clay Suspensions.

In the course of work necessitating the purification of quantities of the smallest soil particles (the so-called clay fraction), a striking phenomenon was observed during the flocculation and sedimentation of the material in dilute hydrochloric acid. Many industrial and laboratory processes entail flocculation and sedimentation, so an account of our own observations may be of general interest. When the concentration of the suspension exceeds a certain critical value—the significance of which will appear later—a number of sharp ramifying fissures develop containing clear liquid. The density of this being less than that of the surrounding clay-laden liquid, a circulation is set up, clear liquid rising through the fissures while the remainder sinks. Some of the fissures form against the glass walls of the vessel, so the progress of sedimentation can be watched in detail. Near the bottom of the vessel the fissures tend to close, and to enlarge progressively towards the top of the column into conical chimneys, through which the motion of the ascending liquid can be traced by the movement of floccules detached from the walls of the fissures. The circulation is completed by the deposition of these floccules in a crater or ring around the exit of the chimney. There is no doubt that the suspension has acquired rigidity. The descending surface retains the initial form impressed on it by the curvature of the meniscus and by occasional air bubbles floating on the water. Marks deliberately made on the clay surface with a rod are also retained.

Weaker concentrations settle much more rapidly; in those less than one-quarter of the critical, the floccules fall individually, whereas at half the critical value the floccules settle *en masse*, leaving a clear supernatant liquid. In the latter case the suspension subsides with a perfectly flat surface, which, when disturbed, shows no sign of rigidity. But as the flocks settle on the bottom of the vessel, a layer is built up which has a concentration great enough to show rigidity. The chimneys already described then form, and extend progressively upwards towards the descending surface. When this is still about 1 cm. above the tops of the chimneys, discrete domes, often exceeding 1 mm. in height and 1 cm. across, are formed over them, and finally each mound develops a well-defined hole at the summit. This stage is shown in the accompanying photograph (Fig. 1).

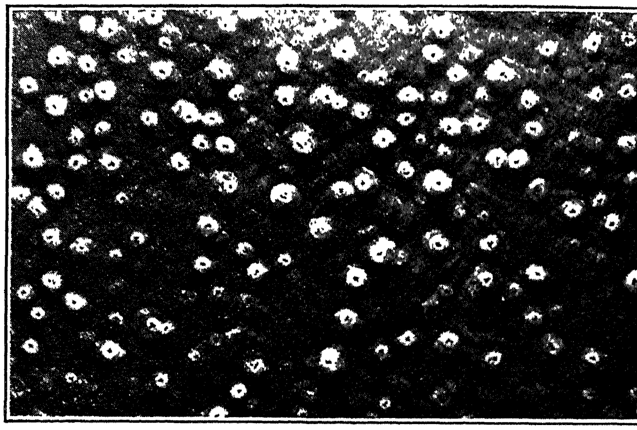

Fig. 1.

It would appear that the clay concentration in the upper layers at the moment of perforation of the mounds is the minimum at which rigidity can occur. An independent test of this point was suggested by other work in progress in this department on the plastic properties of soil and clay pastes: measurements of the rate of flow through a capillary tube under different stresses have demonstrated that departure from the Poiseuille Law occurs only above a certain critical concentration. For our suspensions this value was found to be identical, within the limits

of experimental error, with that in the immediate neighbourhood of the perforated mounds as determined directly on a sample removed with a pipette. The agreement is not affected either by removing the coarser clay particles or by the addition of fine silt, but, as would be expected, the critical concentration increases with the coarseness of the suspension. It is interesting to note that the critical concentration, even in the coarser suspensions, is only about 1·5 per cent by volume.

The above remarks apply to the case in which the minimum amount of electrolyte for flocculation was used (N/1000, HCl). Parallel experiments with strengths up to N/100 show that the amount of electrolyte present is not without influence on the phenomenon. For example, the minimum concentration for rigidity, as determined in the plastometer, is now above that at which mounds develop in sedimentation experiments. There is evidence that this is due to thixotropic gel formation, that is broken down in the preliminary shearing given to the clay in the plastometer before measurements are begun. This possibility will be followed up during further investigations of the phenomenon now in progress.

R. K. SCHOFIELD.
B. A. KEEN.

Rothamsted Experimental Station,
Harpenden, Herts.

Modes of Distribution of the Mudfish in the Philippines.

ON Luzon, the main island of the Philippine archipelago, there are only two real seasonal variations, known as the dry and the wet or rainy seasons. During the dry season, October to May, there is practically no rain. At this time the smaller bodies of water dry out, and lower fields are covered with cracks, crevices and clods running in all directions. Water remains then only in isolated deeper ditches, swamps, and larger rivers. During the rainy season, June to September, everything is flooded. Not only the swamps and ditches, but even the rice fields are full of water. This is especially true in the eastern part of the island. At this time thousands of small fish appear in the rice paddies. They are the young of the fish *Ophiocephalus striatus* Bloch, which is known in English as *mudfish* and in Tagalog as *dalag*. The young fry is known to Tagalogs either as *bulig* or as *anak nang dalag*, that is, the children of dalag.

The Tagalogs have a number of theories concerning the occurrence of this fry in the rice fields. Some hold that it originates from the mud, others that it rains down from clouds, still others, claiming some education, think that the old fish æstivates in the mud, and then when the rains come they emerge and lay the eggs. Some even think that the eggs are laid in the preceding year, remain dormant during the dry season, and hatch when the rains come. The first two notions need not be considered seriously here. The third theory, that the fish can survive in dry mud some five or six months, has no proof. The dalag, aided by its accessory respiratory apparatus, may live in water which is not fit for any other fish to live, but when it comes to a complete absence of water, the situation is changed. It may live for two or three days on a wet market table, but when it jumps out from an aquarium on the laboratory floor in evening, it never survives until the morning. During my five years' residence in that part of the Islands I have never been able to learn from the people of a case where a fish could survive in the mud during the dry season; and I have been making constant inquiries, especially from the country people. The eggs are also very sensitive to the external surroundings. Normally they hatch within two or three days, and do not live through any greater length of time without hatching.

There are three possibilities which may account for the occurrence of the young fish in the rice paddies. The old dalags may swim from rivers into flooded fields and then lay their eggs. There are many well-known instances where freshwater fishes leave the deeper waters for spawning purpose. The dalag is not very particular in this respect, but some of them do actually migrate from deeper to shallower waters, though they seldom reach the rice fields. The young fish if hatched near the rice fields may easily swim into them. They are strongly positively rheotropic, and very good swimmers. The waters receding from the rice fields give the young fish an opportunity to reach them. These two modes of distribution account for a considerable number of cases, but the most important mode of distribution is by means of the eggs themselves.

The eggs of dalag are 'pelagic' or floating eggs. They are quite large (1·25-1·5 mm.), have the germinal discs on one pole, and an oil droplet on the other. The oil being lighter than water buoys the eggs, so that it floats on the surface in such a way that the germinal disc is always submerged just under the surface of the water where the conditions for its development may be considered the best. Such eggs float very easily in any direction, depending upon the wind. During the rainy season the typhoons bring very strong winds. When the fields are flooded and the boundaries between the larger bodies of water and the rice paddies disappear, the wind carries the eggs there. In such a way the eggs may be carried into most unlikely places. After a strong typhoon in Manila, 1927, large numbers of eggs were brought to the University of the Philippines Rizal Hall, right to the door of the Zoology Laboratory. At a distance of about 300 metres on the opposite side of the campus is located a drainage tube leading indirectly to Pasig River. The drainage path itself is more than 300 metres long. The campus is dry throughout the year with the exception of a short time during the stronger typhoons, when it may be submerged for a few days. Much better means of communication are found at such times between the rice fields and the larger bodies of water; and I think that this is the most important means for the distribution of dalag in the rice fields.

P. B. SIVICKIS.

Lietuvos Universitetas,
Kaunas, Lithuania.

Major Segrave's Speed Record of 231· . . . . . m.p.h.

THERE has been much self-satisfied amusement over the five places of decimals in which Major Segrave's speed record on Mar. 21 was recorded in the Press. Truly these are merely arithmetical residues—a waste product. A lad with a healthy sense of what is the good part of an apple scoffs at saving up the skin for microscopic study—it is a waste product.

Let us take to the microscope—at the cost of knowing a little more and laughing a little less.

To the Royal Automobile Club, Sir Charles Wakefield gave not only a £1000 Trophy but also a £1000 a year for the 'world's record' holder until he is beaten. If the amount were 6*d*. the moral compulsion to enforce the letter of the law in sporting matters remains, but I quote the amounts to impress the Philistines.

Now thirty years' evolution of motor-racing has

saddled us with history, precedents and rules. In this case the rules call for:

(1) A level track of officially certified length properly surveyed—gradient tolerance, etc.
(2) Automatic timing to $\frac{1}{100}$ sec.
(3) A to-and-fro run—not only to eliminate gradient effect but also to average the wind effect (otherwise *all* attempts would be made in a following gale of wind).

Following horse-racing precedent, the *written record* itself was not a velocity in miles per hour, but a *time*. It was the average of the two times actually measured. For popular consumption a speed has been worked out from this mean time, and this, though it is *not* the speed of the vehicle, is universally taken as such, and it is now treated as the record.

(I explain that the true mean speed is the mean of the two speeds, on the runs, and not the result of dividing the length by the mean of the two times.) When a record has stood unquestioned beyond the delay for appeal, it is established and cannot be altered. This protects holders from having to fight for their title up to an indefinite date. Looking as we are through a microscope, all this is very wrong scientifically—in practice it is not very significant.

Now in doing the prescribed arithmetic there appear these wasted decimals and no provision for ignoring them. The first step to a remedy is to pass a new rule that records shall not be deemed beaten unless the new performance exceeds the last by x m.p.h., and such a resolution has been placed on the agenda of the A.I.A. (The International Association of Automobile Clubs) by the Royal Automobile Club, but I greatly doubt if it will be carried—for two reasons:

(1) Rigidly speaking, a bit of true speed should not be added to a numeral which is not a speed.
(2) In fairness to the next competitor, the existing record-holder should not be protected in his tenure of the spoils (the £1000 a year) with an excess—which he himself was not subjected to, since this partakes of altering the rules of a contest while it is in being.

Those who say that I am caring *de minimis*, do not realise how jealously these preferences, however small, are regarded. Reason (2) will not, I surmise, be raised, but it may well dominate the discussion. What will be raised is the objection to breaking the comparative position of the items in the list of records. The War has probably played havoc with the archives of the earlier records so that they could not well be written up in terms of the new method of calculation (mean of velocities in lieu of mean of times).

For the ordinary man the speeds are substantially as given: for the clever man they are still as given, and in addition they afford him the added pleasure of feeling clever. Shall we not continue to spread happiness among the wise? MERVYN O'GORMAN.

The Athenæum,
Pall Mall, S.W.1.

Colour and Optical Anisotropy of Organic Compounds.

I DESIRE to direct attention to a significant and very generally valid relation which emerges from an examination of the data accumulated by eight years of systematic research at Calcutta on the scattering of light. The generalisation may be stated thus: *The types of molecular structure in carbon compounds which favour the development of colour are those which exhibit an exceptionally high degree of optical anisotropy.*

When we compare a series of compounds in respect of their optical anisotropy, and their colour as indicated by the position of their absorption-bands in the spectrum, the parallelism between the development of the two characters becomes evident. Thus, the aromatic series of compounds are generally more anisotropic than the aliphatic series. We have large increases of anisotropy when we pass from pyridine to quinoline, or from benzene to naphthalene and thence to anthracene. The introduction of a chromophore like NO_2 or auxochrome like NH_2 as a substituent in the benzene molecule produces a notable increase in anisotropy. Less striking but perfectly definite increases occur when halogens of increasing atomic weight replace the hydrogen atom in the benzene ring. In the disubstituted benzene derivatives, the relative position of the groups influences the anisotropy appreciably. These and many other instances may be cited to show that an increase in optical anisotropy connotes a development of colour.

That variations of structure in carbon compounds should influence the two optical characters of anisotropy and colour in similar ways need not occasion surprise when we recollect that the element carbon in its two states, diamond and graphite, itself exhibits the same tendency. Diamond is a transparent and isotropic dielectric, while graphite is opaque, conducts electricity, and has a highly anisotropic structure as shown by X-ray analysis and by its diamagnetic behaviour. C. V. RAMAN.

210 Bowbazar Street,
Calcutta, Feb. 28.

Magnetic Storm of Feb. 26–28, 1929.

IN the Astronomical Column of NATURE of Mar. 9, mention is made of the auroral display of Feb. 27. The display, as seen from various places in the British Isles, particularly in north-east Scotland, has been fairly fully described in the daily press. The accompanying magnetic storm was notable on account of the magnitude of the fluctuations of magnetic force. A detailed description of the storm would occupy too much space, but information on any particular point could of course be given, on application, to anyone interested.

At the Lerwick and Eskdalemuir magnetic observatories, it has been customary for some time to run additional auxiliary sets of magnetographs of lower sensitivity than the standard instruments, so that a reasonably complete record, even of the extreme fluctuations in storms, may be available. In the present case Mr. Lee of Lerwick Observatory reports that the lower limit of registration, even of the auxiliary Horizontal Force instrument, was exceeded from 28 d. 1 h. 3 m. to 8 m. The ranges of variation actually recorded at Lerwick were 3° 57′ in Declination, $>1885\gamma$ in Horizontal Force and 940γ in Vertical Force ($1\gamma = 10^{-5}$ C.G.S. units). At Eskdalemuir, as is usually the case in the great storms, the ranges were of roughly half the above order, being in fact 2° 8′·8 in Declination, 916γ in Horizontal Force, and about 690γ in Vertical Force.

The last occurrence of a storm with variations of magnetic force of the above order was on Oct. 13–16, 1926. On that occasion a magnificent auroral corona was seen from many parts of the British Isles and northern Europe. The ranges recorded at that time were, at Lerwick, 3° 41′ in Declination, $>1068\gamma$ in Horizontal Force and $>2086\gamma$ in Vertical Force; and at Eskdalemuir $>957\gamma$ in the West Component, $>719\gamma$ in the North Component, and $>624\gamma$ in the Vertical Component. A. H. R. GOLDIE.

Meteorological Office,
Edinburgh, Mar. 15.

The Bronze Age in Southern Africa.

By Prof. RAYMOND A. DART, University of the Witwatersrand.

IN view of the impetus which has been given to the metallurgical analysis of ancient copper and bronze objects by the initial investigations of Prof. John Sebelien of Aas, Norway (NATURE, Jan. 10, 1924), and the practical activity of the British Association Research Committee which has resulted in the important interim report embodying the recent investigations of Prof. C. H. Desch (NATURE, Dec. 8, 1928), it is ardently to be hoped that funds will not be lacking for following up Prof. Bernard W. Holman's suggestions (NATURE, Dec. 29, 1928) concerning the further collection and publication of data about the ancient mining industry and the products thereof which are available in southern Africa.

It has been the uniform experience of those who have investigated the ancient mining industry in South Africa that the work has been on so gigantic a scale as to preclude any belief that the products of the industry were consumed by a local population. Beginning with the investigations of Mr. T. G. Trevor, at that time Inspector of Mines for the Union Government, and now holding a similar post for the Rhodesian Government, several important papers by Woodburn and Baumann and others have been published in the *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa which established not only the above-mentioned conclusion but also the further important deduction that the early copper-, tin-, micaceous iron- and ochre-getters had the same sort of industrial implements as the ancient gold-getters of Rhodesia and the north-eastern Transvaal.

On similar lines of reasoning it was possible for me (NATURE, June 21, 1924), by gathering together information from these and other sources, as well as by my personal investigations, to put forward the thesis that the enormous ancient mining district from Katanga and Broken Hill to Pretoria, and from the Kalahari to the eastern coast, formed a single cultural unit.

In the *South African Geographical Journal* of that year I developed the same view in an article on "The Ancient Mining Industry in South Africa," and in NATURE, Mar. 21, 1925, p. 425, was enabled, through the remarkable researches of Bro. Otto, to demonstrate some of the objective proofs that are to be discovered in Bushman cave shelter paintings in the Cape Province, Natal, and Rhodesia of alien intruders wearing headgear of Babylonian and Phrygian appearance.

The great age of at least one of the mines was demonstrated by me in "The Rooiberg Cranium" (*S.A. Journal of Science*, vol. 21, 1924), when I pointed out the existence of a stalagmite fifteen feet high and eight feet thick, in its narrowest part, extending from the roof to the floor, thirty to forty feet from the entrance and in such a position as to render practically certain its formation since the period of occupation by the miners.

It was, therefore, with considerable confidence that I boldly suggested in my article on "Nickel in Ancient Bronzes" (1924), that, as Sebelien had failed to find nickel-carrying ores in the sites of ancient mines in the Arabian and Mediterranean areas, the probable source of the nickel-contaminated copper and tin for the ancient Near East was southern Africa.

At that time, although it was known that there was ample evidence of smelting operations in the Rooiberg area, and a piece of bronze slag had been discovered which had provided in the hands of Mr. Schoch the analysis revealing about 3·0 per cent of nickel which has now proved of such significance, there was no conclusive proof that bronze had been intentionally fabricated at Rooiberg.

This important corroboration of the view advanced by me was forthcoming at the Pretoria meeting of the South African Association (1926), when Dr. Percy A. Wagner (*S.A. Journal of Science*, 1926) revealed the amazing discovery of Mr. Gordon of "no fewer than thirty distinct furnaces on the farm Blaauwbank, No. 433, and alongside of some of them . . . small separate stacks of hand-cobbed tin and copper ore . . . also accumulations of nodular aluminous surface limestone and hand-cobbed iron evidently used as a flux. In the furnaces themselves were found 'slugs' and 'frills' of bronze, many of them still embedded in an iron-rich slag. The largest slug weighs 31·3 grammes."

"Here, then," as Dr. Wagner stated, "is definite proof for the first time that these ancient metallurgists had deliberately set out to make bronze, and that they were thus evidently acquainted with the properties and uses of that important alloy."

The reason for the admixture of nickel with the ores at Blaauwbank by the bronze makers was also proposed by Dr. Wagner, who pointed out that on the farm "there is, in addition to important tin and copper deposits, a nickel lode carrying at the outcrop big masses of apple-green 'nickel-bloom' or anabergite. This bears a remote resemblance to malachite, and it is probable that the ancient miners, who could not fail to have noticed this outcrop, mistook it for that mineral and thus introduced nickel into their bronze." The objects demonstrated by Dr. Wagner are now in the Social Anthropology Museum of the University of the Witwatersrand.

Irrespective of any other question, there has, therefore, been established by incontrovertible evidence the existence in South Africa of a definite Bronze Age period. Such a phase of South African prehistory has not hitherto been recognised by antiquarians, and naturally enough since the bronze objects which in other lands symbolise the existence of such a period have not been found here, but rather only the raw materials of mines, furnaces, and dumps which must have contributed to the blatant bronze cultures of more advanced cultural centres.

The second conclusion that is warranted from the facts is that the "ancient mining period" in South Africa dates back to the Bronze Age, seeing that the

methods of exploitation of the copper, tin, gold, and iron fields are culturally uniform. It can scarcely be that the whole industry was of one age: its very immensity demonstrates that it must have had several phases. The remote antiquity of at least one phase cannot, however, be questioned.

It is of the utmost importance that the Bantu peoples when first discovered did not belong to a 'bronze' but to an 'iron' culture, and there is no evidence to show that they evolved through a bronze phase to the iron phase. We are forced to conclude that the highly intricate metallurgical processes of bronze-making demonstrated by the deposits at Blaauwbank betray the actual presence there at a remote age of skilled and intelligent craftsmen from a superior cultural area. Seeing that the deposits are half-way across the continent, some estimate may also be arrived at concerning the lengthy period of South Africa's exploitation by that superior race utilising the bronze.

To the physical anthropologist who has lived in South Africa and had the opportunity of seeing and dissecting representatives of practically every tribe in the south-eastern end of the continent, there is concrete evidence in the thousands of negroid inhabitants with straight, aquiline, and hooked noses, elevated nasal bridges, reduced lip fullness, and lack of prognathism, to demonstrate beyond cavil the flood of Semitic and other Caucasian blood which flows in the veins of the Bantu peoples; just as the presence, in a more reduced proportion, of Mongoloid eye-folds, slit-like eyes, and high cheek bones of the "Snese Hottentoten" of the Eastern Province and the Bantu tribes of the eastern coast generally reveals past, but probably more recent and less widespread, contacts with the Far East.

With regard to the actual date of the Bronze Age in South Africa, it seems clear that being provoked by one or more alien races who were interested in raw bronze and being absolutely dependent upon that alien interest (as the lack of a typical and separate local bronze industry, such as those of Europe, demonstrates), there can be little question that the South African Bronze Age synchronises with the Bronze Ages of the nearest ancient cultures, namely, those of Egypt and Sumeria. The importance to South African prehistoric chronology of the further prosecution of this absorbing piece of detective work in metallurgy and the exact chronological establishment of the different ancient mining phases can scarcely be overrated.

Fifty Years of Marine Refrigeration.

THE important subject of refrigeration on shipboard has recently been dealt with in three papers by Mr. A. Greenfield, Mr. G. W. Daniels, and Mr. H. J. Ward, read respectively to the Institution of Marine Engineers, the British Association of Refrigeration, and the Institution of Mechanical Engineers.

One of the earliest contributions to a technical society on this subject was the lecture of Alexander Kirk to the Institution of Civil Engineers in 1884, while two years later J. B. Lightfoot read a paper to the Institution of Mechanical Engineers on refrigerating and ice-making machinery. Associated with the production of artificial cold were the experiments and inventions of Cullen, Leslie, Carré, Gorrie, Tellier, the Bells, Coleman, Linde, Haslam, and others. To Gorrie, an American doctor, we owe the first machine which caused compressed and cooled air to expand in working a piston in a cylinder, his patent being taken out on Aug. 22, 1850. Five years later, Gorrie died at Apalachicola, Florida, and there are memorials to him in that city and in the Statuary Hall of the Capitol, Washington, D.C. It was not, however, until about twenty years later that the matter was taken up seriously, and refrigeration on shipboard may be said to have come in definitely with the voyage of s.s. *Strathleven* in 1879, just fifty years ago. The *Strathleven* was fitted with a Bell Coleman cold-air machine, and brought home a small cargo of frozen meat from Australia. As Mr. Ward said, that marked the economic beginning of the industry. The Bell Coleman patents were then acquired by the late Sir Alfred Haslam; one of his first machines was fitted in the liner *Orient* in 1881, and in 1889 some 2,000,000 carcases of beef and mutton were brought to England, most of them in ships having Haslam's machines. Compressed air machines then began to be replaced by machines using other gases, and to-day about 80 per cent of refrigerated cargo ships use carbon dioxide and 18 per cent ammonia; the advantages and disadvantages of which were touched upon by both Mr. Ward and Mr. Greenfield.

Nearly every writer on refrigeration acknowledges the great debt this branch of engineering owes to the scientific investigator, and frequent reference is made to the well-known standard treatise, "The Mechanical Production of Cold," by Sir Alfred Ewing. Refrigeration in all its aspects is almost entirely the outcome of research, and the various investigations now being made by the Food Investigation Board, at the Low Temperature Research Station at Cambridge, and at the National Physical Laboratory, are of great value to the industry.

Fish, meat, cheese, butter, apples, oranges, bananas all require different treatment, and the refrigerating engineer is faced with many problems. Mr. Greenfield's review of the arrangement of a large refrigerated cargo ship is of especial interest. With a sectional profile of such a ship, he gave particulars of the mechanical appliances and piping. The ship he described has 54 independent insulated cargo spaces of a total capacity of 560,900 cubic feet cooled by 37 miles of brine-cooling pipe divided into numerous circuits. The temperatures used vary from 10° to 20° F. for fish and butter, to 34° to 40° F. used for vegetables and fruit. Frozen meat is kept between 16° to 24° F., and chilled meat at 29° or 30° F.

Fruit was first brought to Great Britain from the

West Indies in 1886 in the s.s. *Nonpareil*, apples were successfully carried home from Australia in 1888 in the s.s. *Oceana*, while the banana trade began in 1900 " through the enterprise of a Liverpool shipowner who sought to aid a British colony at the call of a great Colonial Secretary." This trade has grown to such an extent that in 1927 more than 18,000,000 bunches of bananas were shipped from the Gulf ports to depots in Great Britain and European countries.

Hitherto, refrigerating machinery has been driven by steam, but compressors and pumps are now sometimes connected to electric motors or to oil engines. In one of the fine new Nelson liners, the motor ship *Highland Monarch*, of 14,137 tons gross, which made her maiden voyage last autumn, the insulated spaces have a capacity of 500,000 cubic feet. The ammonia compression system of refrigeration with brine circulation is used, the ammonia compressors being driven directly by two four-cylinder Diesel engines of 300 horse-power each. Brine at four different temperatures is available for circulating through the various chambers, flow meters being used to indicate the amount flowing in each circuit. All such installations are erected according to the rules and under the direction of the surveyors of Lloyd's Register, who also periodically inspect the ships on behalf of the insurance and other interests involved. During 1927–28 installations were fitted in 62 vessels with a total insulated capacity of 5,500,000 cubic feet, while on June 30, 1928, 424 vessels held the Society's Refrigerating Machinery Certificate with a total capacity of more than 76,000,000 cubic feet of insulated space. Ships, however, are but the connecting links between the producers abroad and the distributors at home, and the extensive nature of the refrigeration industry in Great Britain and Ireland can be judged from a glance at the Ice and Cold Storage Trades Directory for 1926, a book of some 236 pages.

Evolution through Adaptation.[1]

By Dr. F. A. BATHER, F.R.S.

IT is a hundred years since Francis Egerton, Earl of Bridgewater, died, leaving a sum of money for the preparation and publication of works " On the Power, Wisdom, and Goodness of God as manifested in the Creation." At least half of the eight Bridgewater Treatises thus engendered exemplified their subject by the fitness mutually subsisting between living creatures and the outer world. The facts which by them were so easily explained have presented to us one of the fundamental problems of biology. The first question is : How far are animals and plants really fitted to their surroundings ? Then, if not, why not ? And again, in so far as they are fitted, how did they become so ?

No living being can be considered without its surroundings ; indeed, it is hard in some respects to say where the creature ends and its surroundings begin. An individual must be fitted to its surroundings, or must make some effort, conscious or unconscious, to become fitted. Thus when we observe the multifarious forms of life fitted adequately, if not always perfectly, to varied habitats and modes of living, we need feel no surprise, and we perceive no difficult problem.

Geology, however, has taught us that conditions have constantly been changing, and that the forms of life also have changed, and it has revealed to us a succession of creatures constantly becoming fitted, or as we say adapted, to diverse conditions. The problem is no longer the fitness of the individual, but the adaptation of the race or lineage. An individual is adaptable, but only up to a point, and any increased fitness of the individual is not—at any rate in the vast majority of cases open to human observation—handed on to the offspring. How then are we to explain the fact that numberless series of forms have gradually changed, and so changed as either to accommodate themselves to changing conditions or to become (in most instances) more and more fitted to diverse states of life ?

Many answers to this question have been propounded, but, since controversy still continues, it is plain that none of them is wholly satisfactory.

A theory of revolutions of the earth's surface, each accompanied by a special creation of fresh forms of life, has long ceased to fit the known facts. Even if an external guiding power were admitted, one would still seek to discover the mechanism through which it worked. From such a theory it is but a step to the conception of development in definite directions, each according to some predetermined plan. Palæontologists have indeed made known to us in various groups of animals numerous series, each apparently following a trend of evolution, and some have claimed each trend as inevitable and, accident apart, predestined. But it will be realised that any line of evolution, as we look backwards, appears to have been regular and inevitable. From eolith to steel axe the ascent is straight and unbroken. It is just because the later shape proceeds so naturally and, to all appearance, inevitably out of the former shape that we can speak of an unrolling or evolution. But when we examine any such line more minutely we find that matters are not so simple. Take the evolution of either the horse or the bicycle and it will be found that there are some side-lines which failed to win approval, others that were adapted for special conditions and so diverged ; or two stocks of different origin and structure may have been similarly moulded to meet a similar environment and have thus assumed a close resemblance. Clearly predetermination cannot apply to such cases, and therefore cannot be called in as a general expression of evolution.

Broadly speaking, there is a conflict between the view of evolution as essentially a process of

[1] From the Friday evening discourse, entitled " Lily-stars of the Sea : How they Fit their Surroundings," delivered at the Royal Institution on Feb. 22.

adaptation, and the view that it follows predestined courses. The essence of the latter view is that the trends do not necessarily accord with the surroundings, but may indeed run counter to them, so that the lineage ceases to be fitted and comes to an inevitable end. Now it cannot be denied that, according to our present lights, there are such examples of evolution at cross-purposes with environment. Any solution of the problem of adaptation must apply also to maladaptation.[2]

The problem may be limited and perhaps clarified if taken in connexion with another generalisation of palæontology—the irreversibility of evolution. This, which we owe to Louis Dollo, states that a structure once lost is never regained. Should the need again arise for the performance of the same function, some other organ must be modified for the purpose. This irreversibility may be extended to the history of the lineage. There is, all must admit, a curious parallelism between the development of the individual and that of the race; and, just as the individual's growth never really returns on itself, so is any true rejuvenation excluded from the history of the race. More obviously connected with irreversibility is a further generalisation, particularly associated with the name of D. Rosa, stating that a race as it progresses loses its power of adaptive change. At first it can vary in numerous directions and is not bound to any one road. But every step that it takes in one of those directions forbids its return to seek another path. Thus by degrees all roads but one are barred to it, and if that one road ceases to lead to salvation, the race must perish.

Let us combine these statements of palæontology with the geological teaching that from the beginning the surface of our planet has constantly been changing, a fact that has involved, *inter alia*, changes of climate, changes of depth and salinity in the waters, and migrations of their inhabitants. It follows that the surroundings of a race are continuously altering; the race has perpetually to catch up with the change: in so far as the external changes proceed in the same direction, so do adaptation and specialisation follow in what seems to be a definite trend. Now suppose the external change to be diverted from the normal course, then a race that by its specialisation has cut off all chances of adaptation to the new conditions will necessarily perish. Or suppose the external change merely to cease; it does not follow that the internal conditions of the organism will cease to move along the line hitherto found beneficial; thus arises the phenomenon of a trend which, beginning in harmony, has been turned to disharmony.

This seems to be a fair expression of well-known facts. It suggests to us that not only is there irreversibility and a consequent loss of adaptability, but also that there is some tendency for change of form and structure to proceed in a definite direction. In most cases the direction will accord with the environment; otherwise the world would cease to be peopled. In the remainder, and eventually in all cases, the direction becomes in disaccord; the race dies out, and its place is taken by one more adaptable. Hence special evolution of the race is replaced by that general evolution of the world-population which we call progress.

Consideration of the two chief theories of the evolutionary process in the light of modern knowledge has seemed to point to this same conception of an internal direction.

The Lamarckian theory, thus regarded, implies that a modification of the individual to meet the pressure of the environment is somehow transmitted to the germ-cells, and that these produce an altered offspring, or mutant, already in accord with the environment. It is generally agreed that characters are transmitted from parent to offspring through the chromosomes or nuclear elements of the germ-cells. Now it is known that change of outer conditions (food, light, temperature, moisture, and the like) may have such a physico-chemical action on these chromosomes as to induce some change or mutation; but if, as the Lamarckian theory demands, the mutant produced is just the one that fulfils the requirements, we still have to ask why this should be so.

In most cases that appear to exhibit a direct action of some outer physical agent, it may be that the agent merely stimulates mutation, and that among numerous mutants only those survive which harmonise with the environment. The remainder may never actually come to birth, and even fertilisation may be hindered by a change in the germ-cell due to external influences. Such instances in fact are familiar to geneticists. When the stimulus of a changed condition is continued through long ages, the probability of its producing a mutant in harmony with the requirements is enormously increased.

In so far as this is a true reading of the facts, it implies that the apparent Lamarckian effect is nothing but a special case of the Darwinian selection. But, whereas Darwin called on unstable random variations to provide the material for natural selection, Mendel, De Vries, Morgan, and others have shown that the new material really consists of stable, true-breeding mutants. So far from upsetting the Darwinian theory, that emendation makes it more workable; and if to it we add the conception of an early massacre of unsuitable mutants, the tempo of the selective process will be further accelerated.

It is possible to imagine still greater speeding up by viewing selection at a different angle. The Darwinian regards what he calls Nature—that is, the totality of environment—as the selector. But what if we lay the burden of selection on the creature? No more in this case than in the former is any conscious choice implied. An animal with defective pigment and sight will not escape its enemies unless it skulk in dark corners. A mutant that can exist only in warmer water than that supported by its parents will perish if it do not find such a habitat. Individuals that happen on suitable conditions will be saved.

[2] Examples of suicidal evolution, mostly instances of excessive calcification, are well discussed in various works of W. D. Lang, who has recently given a brief summary, "Form in Fossils," *Proc. Geol. Assoc.*, 39, 429-44, January 1929.

A population is subject to both kinds of selection. Whether the environment of a given locality change or no, the fit among the offspring that remain in it are passively selected by Nature; those that migrate, because uncomfortable, actively, though accidentally, select a fit habitat. Thus arises divergence.

If the problem of adaptation is brought nearer to solution by these modern extensions of theory, there remain the questions of irreversibility and trends, especially those that seem to us out of harmony with the environment. Those phenomena suggest a tendency of mutation to follow the change of environment; and they do so far more than the rare and somewhat doubtful instances in which an experimenter claims to have produced a heritable modification, or a mutant conforming to some modification that he has produced by outer stimuli in the adult parent. If, then, we could find some general principle governing mutation, we might approach an explanation of the whole evolutionary process.

May I suggest a possible direction of search for such a principle? The evidence thus far available indicates that mutation depends on some physico-chemical change in the particles that make up the chromosomes of the male and female germ-cells. That chromosome particle, or gene, on which a certain structure of the adult is believed to depend, must have a chemical constitution more complicated than that of any organic compound as yet elucidated by chemists, but the changes in its composition must follow the same laws.

The ordinary chemical changes of living substance are reversible; that is a character of life; a compound broken down is at once reformed. But certain reactions are irreversible, and conspicuous among them is the whole process of growth and senile decay. If, then, some external agent produce a change in the molecular arrangement of a gene, that change may well be irreversible. Indeed, the mere removal of the external agent could not be expected to cause a reversal of the reaction. Again, just as other irreversible changes in an organism proceed in definite directions, so a succession of changes initiated in a gene would be likely to follow a single line. Whether a chemical change consist in the loss of a molecule or in a rearrangement of molecules, it seems that the number of possible changes would become increasingly limited. This limitation would, in course of ages, apply to each of the genes.

If the changes in the genes were merely random, then the organism would be just as likely to vary in a negative as in a positive direction. But if the evidence convinces us that variation is more in a positive direction, then the changes in the genes cannot be random, but must be produced or controlled by some factor external to them.

How, precisely, external influences are conveyed to the chromosome particles is another question. Some researchers, as J. T. Cunningham, rely on the action of hormones, internal secretions conveyed by the blood to the germ-cells. But what happens when the hormones get there? The chromosomes lie in the plasma of the germ-cell, and it has long been recognised that this is not without effect on inheritance. Now Hirata has recently described a chemical mechanism by which a change in this plasma acts to some extent on the gene. At first the influence is manifested in the adult offspring as a non-heritable modification, but it is suggested that a continuance and intensification of the stimulus might be so firmly impressed on the gene that the change would be passed on to the offspring. Thus the modification would become a mutant, and our problem would to that extent be solved.

I have attempted to keep my speculations consistent with recent work in genetics and biochemistry. If some such physico-chemical structure be admitted as the basis of variation, and if the irreversibility of the chemical changes in it be allowed, then it seems to provide that fundamental premise from which, in combination with a varying environment, one can deduce irreversibility of evolution, reduction of variation, and orthogenetic trends. The decisive principle is still natural selection, but the material on which selection acts is not supplied at random; it is subject to certain laws, and those laws assist the progress of that evolution of life which is revealed to us by palæontology.

Obituary.

DR. H. BRAUNS.

HANS HEINRICH JUSTUS CARL ERNST BRAUNS, who died on Feb. 3 at his residence in Willowmore, Cape Province, at the age of seventy-two years, was born in Hannover, Germany, and spent his school-days in Mecklenburg, where he also entered the University, obtaining the Ph.D. degree. He studied medicine at several places, including Göttingen and Leipzig, from which latter university he obtained the M.D. degree. The honorary degree of D.Sc. was conferred upon him in 1928 by the University of Stellenbosch in recognition of his services to entomology in South Africa. He was a member of the Royal Society of South Africa, and shortly before his death was elected an honorary member of the Société des Sciences Naturelles, Musée du Congo Belge, Tervueren.

On the completion of his medical studies, Brauns travelled in the East, India, and North, Central, and South America. In 1895 he went to South Africa, settling eventually at Willowmore in the Karoo, where he worked until 1925.

Brauns collected insects all over South Africa, but mostly from the Karoo. His chief interest was centred in Hymenoptera, his collection of which is now in the Transvaal Museum, Pretoria. He published numerous papers, memoirs, and monographs on South African Hymenoptera, especially on the Apidæ, Sphegidæ, Masandæ, and Chrysididæ, and his systematic work on genera such as

Cerceris, *Crocisa*, *Epeolus*, etc., is important. He was a keen observer and first-class field naturalist, and his many observations on the habits, development, nest-building, prey parasites, food plants, and general bionomics of Hymenoptera have earned for him a prominent position as an entomologist. He also contributed to our knowledge of termitophilous and myrmecophilous insects. His indefatigable spirit prompted him to collect even up to the last, and shortly before his death he published descriptions of new Chrysididæ.

THOMAS OWEN BOSWORTH, who died in London on Jan. 18 last, was born at Spratton, Northamptonshire, on Mar. 28, 1882. He was educated at St. John's College, Cambridge, and was on the staff of the Geological Survey of Scotland in the years 1908 and 1909. The remainder of his life was mainly spent abroad as an oilfield geologist. In this capacity he travelled extensively in America, ranging from Peru to within the Arctic circle. His published works include "The Keuper Marls around Charnwood" (Leicester, 1912), "Geology of the Mid Continent Oilfields, Kansas, Oklahoma, and North Texas" (New York, 1920), "Geology of the Tertiary and Quaternary Periods in the North-West Part of Peru" (London, 1922), and several papers in the *Geological Magazine*. In the work on Peru, Bosworth gives a fascinating account of the later geological history of the region, and his description of the present conditions and processes in the desert is full of interest to both geologists and geographers. By his death at the early age of forty-six years, geology has lost a very able investigator.

News and Views.

THE Soviet Government has now completed the first part of an extensive electrification scheme which was begun almost immediately after the Revolution. A large 80,000 h.p. hydro-electric station has been built on the River Volkhov about 80 miles east of Leningrad. The power is supplied to Leningrad by overhead lines at 120 kilovolts. The Swedish General Electric Co. (Asea) supplied most of the equipment and assisted in the planning of the station. Metropolitan-Vickers Electrical Company of Manchester also supplied some of the equipment. In the communication between the generating and distributing station, the transmission lines are used as part of the circuit. The communication between the machine room and the control room is by ship's telegraphs. According to Reuter (Moscow), the Soviet Government has also started broadcasting, the control of which has been put in the hands of the Commissariat of Posts and Telegraphs. In addition to radio-technical and agricultural courses, a university has been opened the lectures in which are all given by radio. By means of telephone lines, broadcasting is being extended to isolated villages. A very rapid increase in the number of radio listeners is expected. According to the estimates of the Commissariat, the number of listeners will have increased by a million before the end of this year. Radio theatres have been opened in both Moscow and Leningrad and experiments are being made with radio-films. On Aug. 1 next, a new radio station with a power of 75 kilowatts will be opened in Moscow.

IN January this year, Dr. T. A. Jaggar, Director of the Hawaiian Volcano Observatory, predicted that an eruption of either Kilauea or Mauna Loa was to be expected during 1929. The prediction, based on the cyclic behaviour of the Hawaiian volcanoes first recognised by Dana, was made good in spectacular fashion on Feb. 20. On that day, Washington received the following radiogram: "Kilauea flashed into magnificent eruption at 1:00 A.M. Hawaii time this morning." We learn from a *Daily Science News Bulletin* issued by Science Service of Washington, D.C., on Feb. 21, that the opening phase began with vast fountains of lava, spurting to heights of two hundred feet from a long crack in the floor of Halemaumau Pit. In twelve hours the pit was filled with a lava-lake to the depth of sixty feet. By that time the fountains were still playing to a height of a hundred feet, and the level of the lava-lake was rising at the rate of five feet per hour. Driblet cones formed above the effervescent lava, and from the higher jets liquid drops were blown off to fall, at first as pumice but later as clear brown glass relatively poor in gas bubbles. Quantities of the fine-spun glassy threads known as 'Pelé's hair' have been formed by wind action from the crests of the waves of molten rock. The seismograph at Volcano House records a constant tremor, and an inclination from the vertical away from Halemaumau Pit. Since the eruption started, constant additions have been pouring into the cauldron as a result of landslides of volcanic detritus from the steep slopes of the sides. It is anticipated that the present phase of intense activity will continue for several weeks.

MR. R. A. WATSON WATT delivered the Symons Memorial Lecture of the Royal Meteorological Society on Mar. 20, taking as his subject "Weather and Wireless." Mr. Watson Watt stated that wireless as a means of communication is essential in modern meteorology because it alone is capable of giving sufficiently rapid interchanges of data over wide areas. The results of observations made all over Great Britain are in the hands of the central forecaster within an hour, the majority of the data for Europe are received within an hour and a half, and that for the whole Northern Hemisphere within six hours. It was announced that an experimental transmission from Daventry of daily weather charts is to commence shortly. Wireless has a 'climate' and a 'weather' of its own. The weakening of signals over different kinds of country, according to time of day and season, and the dependence of atmospheric disturbance on latitude, place, and time, are climatological in scope. The quick-period changes, the erratic phenomena of fading, are part of the 'weather' of wireless—atmospherics are its 'rainfall.'

Mr. Watson Watt stated that the average atmospheric is a hundred thousand times as strong as a readable signal. They have been known to disturb broadcast reception up to four thousand miles from their place of origin. They originate in thunderstorms and the predominant source of the world's supply of atmospherics at any moment usually lies in a land where it is summer afternoon. The average atmospheric received in England is of such strength as would be sent out by a thunderstorm 2000 miles away. Speaking of the alleged effects of wireless on weather, Mr. Watson Watt stated that the average rainfall of England requires for its production the expenditure of energy at the rate of a third of a million horse-power per square mile, night and day throughout the year. The total rate of emission of energy from all the broadcasting stations of Great Britain and Northern Ireland, in the limited periods during which they work, is less than 55 horse-power. Any effect of broadcasting on weather would therefore be due to 'sub-homeopathic doses' of less than one in a thousand million. The lecture was illustrated by the reception of current weather maps and written forecasts on the Fultograph system, and by demonstrations of the cathode ray direction finder, a visual direct-reading instrument used for locating wireless transmitters and thunderstorms.

In his Friday evening discourse, delivered on Mar. 22 at the Royal Institution, Sir Ernest Rutherford dealt with "Penetrating Radiations." There exists in our atmosphere a type of ultra-penetrating rays, often called the cosmic rays, of about a hundred times the penetrating power of gamma rays. The frequency of vibration of these cosmic rays is from a hundred to a thousand million times greater than that of ordinary light. For ordinary X-rays, the quantum of radiation, in passing through the atoms of matter, occasionally interacts with one of the component electrons and the whole wave-energy of the quantum is given to the electron, which is set in rapid motion and ionises the matter in its path. The chance of such a conversion of the energy of the radiation, called the photoelectric effect, increases rapidly with the weight of the atom and falls off markedly as the frequency of the radiation is raised. Another process, called scatterings, is also always present. The effect is small for ordinary X-rays, but becomes predominant for very high frequency rays. In this process, called the Compton effect, the radiation is scattered and at the same time the electron is set in motion. The scattered radiation is degraded in frequency in amount depending on the angle of scattering. In very penetrating rays, the average frequency of the scattered wave is reduced to about one-half for each scattering collision, when about half the energy in the average is given to the recoil electron. Consequently, when a very penetrating radiation passes through matter, recoil electrons of high speed, and degraded radiations, are always present. The experimental information is at present too scanty to fix with certainty the origin and nature of these penetrating rays. It has been suggested that they come from outer space, and represent radiations which arise in the destruction or creation of atoms. The energy of the quantum in the most penetrating radiation measured by Millikan is of the order of 1000 million volts. It may prove significant that radiation of this energy may be expected to arise if the proton can be converted into radiation by a single catastrophic process.

The Medical Research Council has lately issued three important monographs in the Special Report Series (H.M. Stationery Office). No. 124, by E. G. D. Murray, gives a critical account of the general biology of the meningococcus, the causative micro-organism of cerebro-spinal fever. No. 125, by Hugh Cairns, is a study of intra-cranial surgery, based upon a year's residence as assistant surgeon in Dr. Harvey Cushing's clinic at Boston, U.S.A. The medical reader, even, will be astonished at what can now be accomplished in this branch of surgery, and it is remarked that, apart from the difficulties of diagnosis and surgical approach, the brain is just as amenable to surgery as are the peripheral nerves. No. 126 contains a summary of reports for 1927 from research centres in Great Britain and Ireland on the medical uses of radium. There can now be no doubt that radium is a valuable adjunct, properly applied, in the treatment of cancers. Some inoperable cases are apparently cured, and even when this happy result does not ensue, life is frequently prolonged and the last days of the patient are rendered more comfortable. Much, however, remains to be elucidated as to the proper dosage, and the best method of application, of radium.

The value of the work carried out at what are termed forest products laboratories is now beyond cavil. The first was established in the United States in Madison, Wisconsin. An important branch of the Research Institute at Dehra Dun, India, is occupied with similar researches; as also a section of the Bureau of Science at Manila in the Philippines. The Forest Products Research Laboratory at Princes Risborough in Great Britain has already been alluded to in Nature. A pamphlet (No. 9, Melbourne, 1928) has been recently issued in which Mr. A. J. Gibson, a conservator of forests in India, lent to Australia for the purpose of the inquiry, discusses the question of "A Forest Products Laboratory for Australia." Mr. Gibson arrived in Australia in August 1927 and spent four months in visiting all the States of the Commonwealth, his report being based on the results of his investigations. In publishing the report the Council for Scientific and Industrial Research, under the auspices of which the investigation was carried out, states that its publication does not assume "that the opinions expressed therein are its adopted views nor that it is intended to follow, in their entirety, the recommendations made."

As a result of his investigations and tours, in which Mr. Gibson acknowledges his indebtedness to the forest and research officers of the various States, he expresses the opinion that the establishment of a central Forest Products Laboratory for the Commonwealth of Australia is advisable. One of the reasons given is a common one, and yet not the less important for that reason. In the past, he says, there has been much overlapping of research work and waste of

money owing to the absence of co-ordination between the various States and the Federal Government in this matter. He recommends the setting up of a central laboratory, and estimates the rough cost as follows: A capital expenditure for erection of buildings and equipment of £49,000; an annual expenditure of £10,400 for the personal staff; and another £8600 for maintenance: or a total for personnel and maintenance of £19,000 per annum.

VOLUME 2 of the *Bulletin of the Hill Museum* (1928) has recently come to hand. The first volume of this publication was completed in 1924, and it is announced that with the commencement of Vol. 2 a part will be issued each quarter. The journal is devoted to the publication of original papers on Lepidoptera based upon the splendid private collections of Mr. J. J. Joicey, housed in the Hill Museum at Wormley, Surrey. Contributions from outside sources are also accepted, provided they deal with collections made for the Hill Museum or are based upon studies carried out there. Among the various papers included in this volume, Prof. E. L. Bouvier's finely illustrated account of the Saturniid moths from the East Indies is important on account of the new species and varieties described. Mr. Arthur Hall's revision of the genus *Phyciodes* and papers by Mr. G. Talbot (and others) on material from Matto Grosso, Brazil, and the Great Atlas Mountains, are also noteworthy. The *Bulletin* is admirably printed, and is illustrated by well-executed coloured and other plates. The subscription price is 30s. per volume, payable to Mr. G. Talbot at the Hill Museum: it is also announced that the *Bulletin* will be sent in exchange for other publications on Lepidoptera.

A SEVERE earthquake, that must have shaken a wide area in British Columbia and southern Alaska, occurred on Mar. 1 at 2.31 A.M. (Eastern Standard Time). The epicentre is placed by the seismological section of the U.S. Coast and Geodetic Survey in lat. 53° N., long. 122° W., or in the strait between Queen Charlotte Island and the mainland. An after-shock, almost as strong as the first, occurred in the same place a little more than an hour later (*Daily Science News Bulletin*, Science Service, Washington, D.C. The epicentre of both shocks lies about 160 miles south-east of that of the Alaskan earthquake of Oct. 24, 1927, which was probably situated near Wrangell and Juneau in the narrow sounds of the Alexander Archipelago (NATURE, vol. 120, p. 667). The central areas of the two earthquakes thus seem to occupy a submarine band parallel and close to the western coast of North America.

UNTIL comparatively recent years, earthworms have been regarded as entirely useful animals, as they benefit the agriculturist by opening up the subsoil and improving the general condition of the land, and also they provide a prolific source of bait for inland fishing. Under modern conditions, however, they are a nuisance on lawns and golf courses on account of the mounds of earth they build up at the entrance to their burrows, which are unsightly and interfere with play in golf. W. R. Walton (*Farmers Bull.*, No. 1569, U.S. Dept. Agric.) epitomises our present knowledge of the life history and habits of earthworms, indicating the chief species that are of economic importance. Earthworms are a favourite food of wild song-birds and domestic poultry. In the latter connexion it should be noted that the eggs or larvæ of the gape-worm are swallowed by earthworms, and if in their turn these are eaten by chickens, the latter may contract the disease of gapes, for which the mortality is very high among young birds. The collection, storing, and rearing of earthworms for sale is a regular industry in fishing areas, and methods used in connexion therewith are described. When it is desirable to reduce earthworms, as on lawns and golf courses, various vermicides may be utilised, including corrosive sublimate, ammonium sulphate, powdered arsenate of lead, and mowrah meal. In flower-pots and flower-beds saturated limewater applied freely to the soil will destroy earthworms and not injure the plants.

AT the end of the third volume of the *Quarterly Review of Biology* (December 1928) the editor, Prof. Raymond Pearl, reports on the cost of the biological books received during the year 1928. These books are classified by origin—United States, Germany, English-American (that is, published in England and imported by a branch in America), England, France, other countries. In the last-named group two expensive books with many plates should be omitted before taking the average price. Leaving these two books out of the reckoning, Germany heads the list—the price per page working out at 1·48 cents, the English-American at 1·46, British Government publications 1·26, United States 1·14, England 1·09, France 0·45, and United States Government publications 0·21 cents per page. Prof. Pearl states that the sample of British Government publications was small and does not give an entirely fair representation of the case. He points out the low cost of the U.S. Government publications, and that French scientific books are still marvellously cheap as compared with the commercially published books of the rest of the world. There has been a slight fall (4·4 per cent) in the cost of biological books produced in England as compared with 1927, but the German books received were 23·3 per cent higher in cost in 1928 than in 1927, and 35·8 per cent higher than in 1926. The corresponding increases in the price of French biological books were 25·0 and 28·6 per cent, but the absolute price is so low that the increases are scarcely significant. Prof. Pearl interprets the feelings of many biologists in Great Britain when he states that it is a question whether the German "publishers are not dangerously close to the point in their pricing of scientific books where they will bring into operation that other sad economic law of which the effect is that absolute returns diminish. There can be no great profit in publishing books at such high prices that nobody buys them."

IN accordance with the recommendations of the recent Committee on the organisation of a Colonial Agricultural Service and of the Colonial Veterinary Services Committee, the Secretary of State for the

Colonies has appointed the following Colonial Advisory Council of Agriculture and Animal Health: Mr. W. Ormsby-Gore (temporarily chairman), Mr. F. A. Stockdale (vice-chairman), Lieutenant-General Sir William Furse, Dr. A. W. Hill, Dr. G. K. Marshall, Dr. E. J. Butler, Prof. T. B. Wood, Dr. W. H. Andrews, Dr. A. T. Stanton, and Mr. R. V. Vernon. The Lawes Trust Committee and the Joint Committee on Research in Animal Nutrition of the University of Aberdeen and the North of Scotland College of Agriculture, respectively, have been invited to give their consent to Sir John Russell and Dr. J. B. Orr serving on the Council. Mr. G. H. Creasy, of the Colonial Office, has been appointed secretary to the Council. No terms of reference have been given, but the Council's functions will be generally those recommended by the Committees named above.

THE International Council for the Exploration of the Sea will hold its annual meeting this year in London on April 8-15. Fifteen countries are now represented on it, namely, Belgium, Denmark, France, Finland, Germany, Great Britain, Holland, Irish Free State, Italy, Latvia, Norway, Poland, Portugal, Spain, and Sweden. The headquarters of the Council are in Copenhagen, and it is there that the annual meetings are normally held. The Council last met in London in 1920, when it first reassembled after the War. On April 12 and 13 special meetings will be held, by the courtesy of the Zoological Society of London, in the Society's meeting-rooms, for the discussion of the fluctuations of fisheries and methods of measuring currents. On April 17 a joint meeting with the Challenger Society will be held at the station of the Marine Biological Association at Plymouth.

A SECTIONAL meeting of the World Power Conference on the "Complete Utilisation of Water Power Resources" will be held at Barcelona on May 15–23, at the same time as the Barcelona Fair. It will be followed by visits to places of interest in Spain. The meeting is being organised by the Spanish National Committee of the World Power Conference, with the official co-operation of the Spanish Government. The subjects to be dealt with are: general hydrological problems; technical problems of water power utilisation; economic and financial problems; legal problems; protective measures and defence works of undertakings. Copies of the technical programme (in English, Spanish, French, and German) with forms of application for membership, can be obtained from The Secretary, International Executive Council, Central Office, World Power Conference, 63 Lincoln's Inn Fields, London, W.C.2.

THE unique collection made by Mr. and Mrs. A. C. Bossom of the crafts of the Indians of British Columbia has been loaned to the Imperial Institute, South Kensington, S.W.7, for display during the period Mar. 27–May 20. The British Columbia Indian or Siwash is a mixture of the Mongoloids and Red Indians, and this heredity appears in his art, as some of it is similar to that of the Chinese and Japanese. His artistic instinct is more highly developed than that of the Red Indian, because he is a house-dweller and not nomadic. The exhibits consist of about 1500 articles, illustrating workmanship in wood, metal, bone, ivory, leather, basketry, etc. It is a curious fact that these Indians had no pottery. The exhibition is open daily on week days from 10 A.M. to 5 P.M., and from 2.30 to 6 P.M. on Sundays. Admission is free.

THE proceeds of the Daniel-Pidgeon Fund for the year 1929 of the Geological Society of London have been awarded to Mr. J. Selwyn Turner, who proposes to investigate the faunal succession in the Coomhoola Grits and Carboniferous Slate of County Cork.

AT the annual general meeting of the Geological Society of London, the following officers were elected: *President:* Prof. J. W. Gregory; *Vice-Presidents:* Dr. F. A. Bather, Prof. E. J. Garwood, Dr. E. Greenly, and Mr. H. W. Monckton; *Secretaries:* Mr. W. Campbell Smith and Prof. W. T. Gordon; *Foreign Secretary:* Sir Arthur Smith Woodward; *Treasurer:* Mr. F. N. Ashcroft.

MOTIONS on the subject of nomenclature for consideration by the fifth International Botanical Congress, to be held at Cambridge in 1930, should be in the hand of the rapporteur général, Dr. John Briquet, before Sept. 30 next. Further information on the programme of work on nomenclature can be obtained from Dr. Briquet, Conservatoire botanique, Geneva, Switzerland.

THE Ministry of Agriculture and Fisheries has issued anew the Leaflet (No. 138) on fowl pox, which has been re-written. It gives a complete summary of the features of the disease, and its treatment, with illustrations. The Ministry also carries out veterinary tests for poultry diseases, a charge of 3*s*. being made for a post-mortem examination, and 10*s*. for a complete examination in outbreaks of bacillary white diarrhœa.

IN our issue of Dec. 1, 1928, p. 860, an account was given of the Kimberley meeting of the South African Association for the Advancement of Science held on June 29–July 4, 1928. The full report of the meeting has now been issued (Johannesburg: South African Association for the Advancement of Science. 30*s*. net). In addition to the presidential addresses, the volume contains all the papers recommended for publication after presentation at the meeting. There are author and subject indexes.

EVERY scientific worker must have had the experience of being asked to recommend for popular reading a book in some branch of his own science, and of being hard put to it to find a satisfactory answer. The Committee of the Leeds Public Libraries has got over the difficulty by inviting experts to compile, with suitable comments, lists of works dealing with all the aspects of various subjects of popular appeal. The lists are published as small booklets at a price of 3*d*. each, and are suggestive library guides. In the scientific series the latest to appear are "What to Read in Zoology" by Prof. J. Arthur Thomson, and "What to Read in Biology" by Prof. W. J. Dakin.

Messrs. W. Heffer and Sons, Ltd., Cambridge, have just issued a catalogue (No. 323) of some 1800 works dealing with agriculture, botany, zoology and biology, chemistry and chemical technology, medicine and physiology, mathematics and physics, including long runs of publications of the learned and scientific societies. The list can be had free from the publishers.

Applications are invited for the following appointments, on or before the dates mentioned :—A temporary zoological assistant for work on the zoological collections of the *Discovery*—The Secretary, *Discovery* Committee, Colonial Office, Whitehall, S.W.1 (April 7). A full-time lecturer on electrical engineering at the Leicester College of Technology—The Registrar, College of Technology, Leicester (April 8). A demonstrator in the department of chemistry as applied to hygiene, at the London School of Hygiene and Tropical Medicine—The Secretary of the School, Malet Street, W.C.1 (April 10). A physics tutor at the University Correspondence College—The U.C.C., Burlington House, Cambridge (April 12). A junior assistant under the Air Ministry, with good general technical knowledge of wireless ground stations, directional wireless and wireless in aircraft, and of development of short wave wireless telegraphy and telephony especially in its use in aircraft—The Secretary, Air Ministry (S.1.), Adastral House, Kingsway, W.C.2 (April 15). An assistant curator in the Royal Botanic Gardens, Kew—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (April 15). A principal of the Shoreditch Technical Institute—The Education Officer (T.1a), The County Hall, Westminster Bridge, S.E.1 (April 16). A principal of the Hackney Technical Institute—The Education Officer (T.1a), The County Hall, Westminster Bridge, S.E.1 (April 16). An inspector of ancient monuments for Wales—The Chief Inspector of Ancient Monuments, H.M. Office of Works, Westminster, S.W.1 (April 21). A chief inspector of the West Riding of Yorkshire Rivers Board—H. F. Atter, 71 Northgate, Wakefield (April 30). An independent lecturer in economics at the University College of North Wales—The Registrar, University College of North Wales, Bangor (May 13). An advisory dairy bacteriologist at the Harper Adams Agricultural College—The Principal, Harper Adams Agricultural College, Newport, Salop.

Our Astronomical Column.

Auroral Arcs on Mar. 14 and 16.—Auroral arcs were seen on Mar. 14 and 16 at 7 P.M. by Prof. H. Bassett and Mr. R. G. Durrant and by several other spectators at Reading. On both occasions the phenomenon presented itself in precisely the same position, but it was fainter on Mar. 16, the moon's light being stronger. The altitude of the brighter part of the arc was approximately 30° above the horizon and its breadth about half a degree. The arc stretched over an expanse from south-south-east to north-north-west or 180°. It passed below Venus, the moon, and Jupiter on one side, and between two bright stars at a considerable distance on the other. Mr. Durrant refers to the event as being an apparition of the zodiacal light, but the aspect of the latter is usually that of a glow in the shape of a cone. He alludes to Sir John Herschel's suggestion that the zodiacal light represents a denser region of planetary material consisting of the tails of comets, while Lord Kelvin considered it as the reflected light from a cloud of meteors revolving round the sun. There is very little if any distinction between these views. Mr. Durrant remarks that if the theory just mentioned still meets with acceptance, this solar crape ring must circulate just within the path of Venus, but the object witnessed in the sky at the middle of March seems to have been consistent with that of an aurora.

Recent Solar Activity.—A large metallic prominence was observed by Mr. Newbegin at Worthing on Mar. 18 at the sun's west limb. He states that the prominence consisted of delicate filaments in a series of interlacing arches culminating in a dense mass at the top which was 105″ in height. This part was dense in helium (D_3). The observation is of interest because it seems likely that this prominence was connected with the disturbed area embracing the large sunspot described as No. 4 in Nature of Mar. 16, p. 425 (for Mar. 5—date when first seen—read Mar. 4). On Mar. 11–13 a considerable magnetic disturbance took place, the measured ranges at the Greenwich station at Abinger being 47′ in declination and 300γ in horizontal force. The storm began with a very pronounced 'sudden-commencement' at 13·9 hr. on Mar. 11 ; the large leader spot crossed the sun's central meridian about 20 hours earlier.

Another Miniature Magellanic Cloud.—Dr. W. Baade contributes to *Astr. Nach.*, 5612, a note on the nebulous object N.G.C. II. 1613, the position of which for 1900·0 is 0h 58·0m + 1° 25′, near 26 Ceti. It was found by Prof. M. Wolf from photographs with the Bruce telescope, and described by him in *Mon. Not. Roy. Ast. Soc.*, **69**, p. 91, as a faint nebulous cloud, 30′ by 40′ in size, with brighter condensations embedded in it. He suggested that it was a cluster of small planetary nebulæ. An exposure by Prof. H. D. Curtis with the Crossley reflector did not lead to any decisive result. Dr. Baade has now taken several photographs with the Bergedorf reflector, with exposures ranging from 50m to 120m. He describes it as a star-cloud of the type of the Magellanic clouds ; the longer exposure gives its dimensions as 14′ 12′ ; the brightest stars in it are of mag. 17 to 18. It appears to resemble N.G.C. 6822 ; a photograph of this by Dr. E. P. Hubble is reproduced in "Astronomy," by Russell, Dugan, and Stewart, p. 804 (1927).

The Light Curve of Nova Tauri, 1927. *Astr. Nach.*, 5613, contains a table and diagram showing the changes in the light of this star, which was discovered at Bergedorf on Nov. 18, 1927, by Prof. Schwassmann and Dr. Wachmann, being then of mag. 9·5.

The Harvard plates enabled the history of the star to be carried two months further back. It was invisible (fainter than 11m·7) on Sept. 11 ; 8m·2 on Sept. 25 ; 6m·0 (maximum) on Sept. 30 ; it sank fairly rapidly to 13m·5 at the end of the year ; there was then a slight revival to 12·5 in March 1928. 13·5 was again reached in mid April, after which the star was lost in the sunlight. An exposure on Aug. 28, 1928, with 30 minutes exposure, gave the magnitude 14·4.

The light curve gives no evidence of the rapid oscillations of brightness which were such a conspicuous feature in Nova Persei 1901 a few weeks after the maximum.

Research Items.

NAGA CUSTOMS.—Owing to head-hunting troubles in 1923 it became necessary for Mr. J. H. Hutton to make two tours to parts of the Naga Hills not hitherto visited by white men. One journey was made in April, the second in October. Mr. Hutton has published a diary of the two tours as No. 1, vol. 11, of the *Memoirs of the Asiatic Society of Bengal*. Many types of implements, utensils, and weapons entirely new to the author were recorded, also new data relating to the burial and head customs, forms of tatoo, etc., as well as much information supplementary to that noted by the authors of the various monographs on the Naga tribes published by the Assam Government. In connexion with the Yungya custom of disposing of the dead in trees, the head being afterwards removed, the sacred tree in question is the *Ficus*, for which some veneration is consistently shown among the Nagas. Among the Wa of Burma and the Dusun of Borneo it is the head tree. The Mafulu of New Guinea use it much as the Yungya, and the Papuan tribes reverenced it. Women in southern India who desire children pay reverence to it, and the Akikuyu of East Africa regard it as the abode of the souls of the dead. It is, therefore, suggested that the beliefs about, and veneration for, the fig tree may be a negroid cult spread all over the Indian Ocean which has grown up into Hinduism from below. Similarly, a negroid belief may survive in the custom of hanging the combs of bees and wasps in the entrance of houses, a custom witnessed everywhere on the first tour. A similar custom is recorded in the Andaman Islands and in the Malay Peninsula. Its occurrence in the Andaman Islands certainly suggests a negrito origin.

THE PURPOSES OF THE PECTEN IN THE EYE OF BIRDS.—In the Doyne Memorial Lecture for 1928, Prof. Arthur Thomson discussed the functions of the pecten in the light of certain experiments carried out by him. He suggests that this curious structure serves other purposes than the nutrition of the vitreous humour and retina and possibly the regulation of inter-ocular pressure. Its pigmentation, position, and structure, all suggest that it may act as a dark mirror which reflects as well as absorbs light. Rays of light, which in the normal position of a bird's head fall upon the pecten from the zenith, have been shown by experiment to be reflected from it, and can be projected upon some sentient part of the fundus, with the great advantage that, so reflected from a dark mirror, they are deprived of the dazzle and glare of bright sunshine and produce a more defined and detailed image. The biological advantage of such a device is obvious, for it means that a bird of prey hovering overhead can be seen even against the sun, and the position of the pecten is such that the threatened victim can fly in another direction whilst still ' keeping an eye ' on the source of danger. The projection of *two* images upon the fundus may enable birds to estimate distance more accurately, a valuable power where dense foliage has to be traversed at speed. Though the pecten in birds is built upon a general plan, it shows remarkable variations in size and form, and these are characteristic of different species.

BIOLOGY OF THE BAY OF PETER THE GREAT (SEA OF JAPAN).—The curious peculiarity of the Bay, according to G. U. Lindenberg (*Priroda*, No. 11), is the fact that its fauna is similar in its character to the terrestrial fauna of the Ussuri region. Even the first explorers of Ussuri noted the mixture of such typically northern forms as the fir and cedar, the sable and the arctic deer, with such typical southern forms as the American vine and the Manchurian walnut, tiger and the racoon-like dog. This is analogous with the aquatic fauna of Peter the Great Bay. The conditions which gave rise to this peculiarity are not the same in the cases of the terrestrial and the aquatic fauna. The climatic conditions of the great ice age played an important part in determining the character of the terrestrial flora and fauna, whilst the aquatic fauna is greatly influenced by the hydrological regime of the Sea of Japan. The occurrence of series of southern forms in the bay during the last three years may be partly explained by hydrological changes of the regime of the bay. It cannot be denied, however, that the southern forms were overlooked by previous explorers. Such typical representatives of the northern fauna as cod (*Gadus callarias macrocephalus*) and dorse (*Eleginus navaga gracilis*) are found among the fishes of the bay. At the same time, many of the southern forms, such as the herring, *Chirocentrus dorab*, *Sphyrna zygæna*, *Alectis ciliaris*, *Priacenthus hamrus*, and others are found in the bay. The sword fish, *Trichiurus Japonicus*, the flying fish, *Cypselurus agoo*, *Stromateoides echinogaster*, *Hemirhamphidæ*, *Scombresociolæ*, *Belsnidæ*, *Mugilidæ*, *Scombridæ*, *Monacanthidæ*, *Tetrodontidæ*, *Triglidæ*, *Echeneidæ*, *Gobiidæ*, and other representatives of southern seas are numerous. So far as is known at present, the fish fauna of the Bay of Peter the Great consists of 233 species, belonging to 53 families. Quantitatively, the fish fauna is richer than that of other Russian seas, such as the Black Sea, the Baltic, the Arctic Ocean, etc. The character of the fish fauna of the Bay of Peter the Great is nearer to that of northern Japan and Korea than to the Okhotsk and the Bering seas.

TWO NEW HYDROIDS.—A. E. Briggs describes (*Records Australian Mus.*, **16**, 1928) two new species of the hydroid genus *Myriothela* collected near Sydney, New South Wales. Six species of the genus are known from northern seas and one from antarctic or subantarctic waters. The discovery of these two new species considerably extends the known range of distribution of the genus. *M. australis* was found attached to seaweed thrown up on the beach and may prove to be a shallow water species. The specimens range in length from 4 mm. to 30 mm. *M. harrisoni* was found on the under surface of rocks below the level of low spring tides. A large number of capitate tentacles is present—up to 1500 in *australis* and up to 600 in *harrisoni*. In both species the gonophores borne by one individual are of the same sex. Both male and female gonophores have an apical opening representing the velar aperture. The salient structural features of *M. australis* are described.

LEAF-FALL IN FROST.—It is well known that frost may cause a premature leaf-fall, but the relation of this phenomenon to the normal process, in which leaf-fall is preceded by the differentiation of a special absciss layer, has seldom been followed in detail. Studies of this nature have recently been carried out by Dr. Anton Mühldorf, who, in addition to observations in the field in the autumn, exposed plants at various stages of development to freezing temperatures which were produced artificially. An account of this work appears in the *Bulletinul Facultatii de Stiinte din Cernauti*, vol. 2, pp. 267-304; 1928. Briefly, his conclusion is that this leaf-fall is a special case of the normal process of leaf abscission, in which the actual separation of the leaf is accelerated as the

result of the changes set in motion by freezing. For example, sap is released into the intercellular spaces where its subsequent expansion on freezing facilitates the separation of the cell walls in the region where abscission takes place. If, however, leaves have not yet commenced to differentiate the usual specialised abscission layer at the time when they are exposed to frost, they die and decay on the plant and do not fall off before decaying. Dr. Mühldorf notes that the vacuole sap released by the cell at the moment of death by freezing has a weakly acid reaction, and this may favour the subsequent hydrolysis of the middle lamella, but this factor alone is quite inoperative in producing leaf-fall unless the usual absciss zone is already differentiated. This paper contains a very full discussion of the general phenomena of leaf-fall accompanied by an extensive bibliography in which, however, British and American work is not cited.

COAL IN SOUTH AFRICA.—The Geological Survey of the Union of South Africa has published the third volume of "The Coal Resources of the Union of South Africa" as *Memoir* No. 19 of the Survey. The first volume contained descriptions of the coalfields of Witbank, Springs, and Heidelberg, and of the Orange Free State, the second volume described the inland coalfields of Natal, and the present volume deals with such of the coal-bearing areas of the Transvaal as were not described in Vol. 1, together with the coalfields of the Cape Province. The Transvaal area here described comprises the Eastern Witbank coalfield, the Bethal coalfield, the Ermelo and Middelburg-Belfast coalfields, the Piet Retief-Wakkerstroom coalfield, and a number of less important fields, such as Springbok Flats, Northern Waterberg, Zoutpansberg, and Komatipoort. The Cape coalfields appear to be of but little importance; the only area in which coal has been worked to any extent is the Stormberg area, but even here the coal is of inferior quality and the seams are thin and much intermixed with shale bands, so that competition with the Transvaal and Natal coalfields is practically out of the question, and the author of the memoir, W. J. Wybergh, states that although there are actually many million tons of coal in existence in the Stormberg coalfield, it is highly improbable that it will ever be economically possible to work it apart from very unimportant local requirements. The important Transvaal coalfields are fully described, the quantities of coal reserves are carefully estimated and numerous analyses are given, so that the present volume may be looked upon as satisfactorily completing the information contained in the two previous volumes on South African coal resources.

PALÆOZOIC INSECTS.—The meagre but interesting fauna of the Rhynie chert found in the Old Red Sandstone of Aberdeenshire comprises a minute branchiopod crustacean (*Lepidocaris*) allied to the *Anostraca* (NATURE, **118**, p. 89; 1926), some arachnids, including the only true mite known in the Palæozoic, and the remains of some minute insects—the only insects known in rocks of earlier date than the Upper Carboniferous. These insects, which were first described by Hirst and Maulik, have been re-examined by Dr. R. J. Tillyard (*Trans. Entomol. Soc. London*, p. 65; 1928), who notes the resemblance of the mandible and antenna to those characteristic of the order Collembola, especially to the family Poduridæ, and concludes that they either belong to that order or are ancestral to it. From comparative morphology it is inferred that the primitive Thysanura must also have been in existence in Devonian times. The specimens consist of four more or less perfect heads for which the genus *Rhyniella* was established by Hirst and Maulik, and some jaw-like structures for which the generic name *Rhyniognatha* is used. In part 10 of his series of papers on Kansas Permian insects, Dr. Tillyard (*Amer. Jour. Sci.* (5), **16**, p. 185; 1928) gives a detailed account of the genus *Lemmatophora*; this has hitherto been referred to the order Protorthoptera, but is now shown to be related to the recent order Perlaria (stone-flies), and is taken as the type of a new order, the Protoperlaria. The wing of a damselfly (genus *Permagrion*) from the Upper Permian of the Falkland Islands has been studied by Dr. Tillyard (*Trans. Entomol. Soc.*, p. 55; 1928). It is the oldest known type which can be definitely referred to the sub-order Zygoptera of the order Odonata (dragonflies), and is allied to the more primitive form *Kennedya* from the Lower Permian of Kansas. The evolution of the order Odonata in Palæozoic times is discussed by Dr. Tillyard (*Rec. Indian Mus.*, **30**, 151; 1928). The characters of the two related orders Protodonata and Odonata are analysed, and it is concluded that the common ancestor is to be found in the Westphalian genus *Brodia* of the order Megasecoptera. The evolution of the Odonata in Mesozoic and Tertiary times will be dealt with in the second part of the paper.

ULTRASONIC RADIATION.—In the February issue of the *Journal of the American Chemical Society*, Schmitt, Johnson, and Olson describe further experiments on the chemical action of very intense sound waves. Iodine is liberated from a solution of potassium iodide, probably owing to the intermediate formation of hydrogen peroxide, since a reaction was obtained when a titanium sulphate solution was irradiated. Solutions containing hydrogen sulphide and air become strongly opalescent after exposure for a few minutes, owing to liberation of sulphur.

EARTH CURRENT REGISTRATION.—Dr. S. K. Banerji, Director of the Bombay Observatory, informs us in a recent communication that he has succeeded in registering earth currents with lines only 250 yards long, whereas usually lines of some miles in length are employed, in order to minimise polarisation effects at the electrodes. He overcomes polarisation difficulties by making the electrodes neutral with respect to the soil, each electrode being a combination of electropositive and electronegative metals, the actual composition being found by trial, and varying with the soil. The neutrality is not maintained indefinitely, and to avoid frequent removal and scraping of the electrodes, small separate electrodes of the positive and negative metals are sunk, and one or other of these is joined to the main as and when found necessary to correct for any small polarisation current that may develop. Such installations have been set up at Colaba and Alibag, which are about 15 miles apart, and about 5 and 18 miles respectively from the centre of the Bombay electric railway network. Photographic records of the earth-currents show the leakage from this network; the oscillations are in excellent agreement with the voltage record at the power station. The amplitude of the oscillations of the leakage current is about 110 microamperes at Colaba, and only 5 at Alibag; the reduction in amplitude agrees roughly with that corresponding to laminar flow. A plane current-sheet of even 5 microamperes is sufficient to disturb the magnetic registers very appreciably. Besides the leakage currents, the earth-current records show the natural diurnal current-variation, and disturbance currents during magnetic storms.

CHEMOTHERAPY WITH LEAD COMPOUNDS.—It is now some years since Prof. Blair Bell first published in the

Lancet an account of the use of lead in the treatment of malignant tumours, and his work has attracted a considerable amount of attention. Another question which has also been discussed recently is that of the toxicity of organic compounds of lead, for example, lead tetraethyl. These two fields of inquiry have lately been combined in an investigation which has been carried out on the chemical side by Dr. Erich Krause, of the Technische Hochschule, Berlin, who contributes a paper to the January number of the *Berichte* (vol. 62, pp. 135-137), and on the pathological side by Dr. W. A. Collier. Various organic compounds of lead (and also of tin) are worked into emulsions with a gum arabic solution, and are injected into the necks of mice. The tolerated dose of substances applied in this way varies considerably, and does not appear to depend on the solubility. Thus triphenyl lead fluoride or triphenyl tin bromide is fifty times as poisonous as diphenyl lead dibromide. Aliphatic and hydroaromatic lead compounds are among the less toxic substances, and are therefore used in the treatment of experimental cancer. A carcinoma emulsion is injected into mice, after which half the animals are treated once with lead compounds as above. The results indicate definite curative effects, the treatment either preventing the development of tumours, or causing tumours to heal after partial development. The most effective substances are found to be tri-normal-propyl lead fluoride, or the less toxic tri-iso-butyl lead bromide, and lead tetraphenyl and tri-cyclohexyl.

AUTOMATIC RECTIFIER SUBSTATIONS. — Recent statistics show that the owners of railway and tramway systems and lighting and power networks are adopting the policy of making their substations completely automatic. This movement began in America, where the need of highly efficient plant is felt very acutely. In Europe the economic conditions involve the factors of high labour costs, the eight-hour day, and the necessity of safeguarding the workman in the best possible way. In the *Brown Boveri Review* for February, a full account is given of the automatic substations this firm has installed for the Brno tramway company in Czechoslovakia. Instead of using rotary converters and complicated combinations of standard relays, mercury arc rectifiers are used. These are of robust construction. In order to connect the rectifier set with the network, it is merely necessary to close two switches. When working with rotary converters it is necessary to synchronise the machines and also verify that the polarity has not been reversed after every operation. The vacuum in a rectifier is maintained by a pump set which is started working or shut down according to the value of the vapour pressure in the rectifier. A time switch automatically closes the circuit breakers. This is the first step in operating the substation. By means of a remote-controlled switch in the distant central power station, the plant is started up or shut down. Should the load become excessive, a thermal relay automatically puts the reserve set into operation. All the control gear is kept in cases which are sealed and completely dust-tight. The average daily efficiency of the rectifier substations is stated to be 92·3 per cent. This compares with an efficiency of 87·6 per cent for a rotary converter station. A brief inspection of these plants is made once a week and their working is controlled in detail every month.

PHOTO-CELLS.—Great progress has been made recently in the development of photoelectric cells or, as they are now more commonly called, photo-cells. Compared with selenium cells, they are much more trustworthy and consistent; unlike them, their response to variations on the light falling on them is practically instantaneous. They have numerous practical applications. Most systems of 'talking films,' for example, use these cells, so as to convert varying light impulses into electrical currents which are applied and reproduced as synchronised sound in loud speakers in the cinema. Another application of importance commercially is to picture telegraphy. Variations of light falling on the photo-cell cause electric currents which can be transmitted by land lines and cables and radio, and are then converted into varying light impulses which are recorded on sensitised photographic paper. In the February number of the *Osram G.E.C. Bulletin*, the principles of the action of this new development are given. The action of the valve depends on the emission of electrons from a suitably prepared metallic surface when light falls on it. The photoelectric currents are extremely small, being of the order of one microampere even with strong sources of illumination. They have the invaluable property, however, of being proportional to the incident light. They can thus be used for most forms of light measurement. They can be made sensitive to particular colours, and this enables them to be usefully applied in practical photometry. It seems certain that within the next year or two practical photometric measurements will be made by their use. Baird uses them in his system of television. A special cell can be made which only responds to infra-red light invisible to the human eye. This can be used as a burglar alarm.

A NEW EQUATION OF STATE.—Paper 5 of Volume 63 of the *Proceedings of the American Academy of Arts and Sciences* gives an account of a new equation of state for fluids introduced by Drs. J. A. Beattie and O. C. Bridgeman of the Research Laboratory of Physical Chemistry of the Massachusetts Institute of Technology. It is $pV^2 = RT(1-\epsilon)(V+B) - A_0(1-a/V)$ where $B = B_0(1-b/V)$ and $\epsilon = c/VT$, a, b, c are constants and the other symbols have the usual meanings. The terms involving A_0 and B_0 represent the effects of the interactions of the molecules of the fluid, while ϵ represents the effects of temperature and density on the time of encounter of the molecules. For this equation $(\delta^2 p/\delta T^2)_v$ is always negative but approaches zero at high temperatures and volumes; p approaches RT/V as V increases and $(\delta pV/\delta p)_T$ at low pressures is negative for low and positive for higher temperatures. The five available constants of the equation are all readily determined from observed data, and comparisons are made between calculated and observed pressures at 1777 points for ten gases and the average difference only amounts to 0·18 per cent.

TANTALUM.—An interesting account by G. M. Dyson of the metallurgy, properties, and uses of tantalum appeared in the issue of *The Chemical Age* for Mar. 2. Since its replacement by tungsten for the manufacture of lamp filaments, tantalum has been utilised as a substitute for platinum. It is unattacked by acids, with the exception of hydrofluoric acid, but reacts with fused alkalis. Hence, tantalum cannot always be employed instead of platinum for making chemical apparatus, especially as it is unsuitable for use above red-heat, when a superficial oxide film is formed and nitrogen is absorbed. Tantalum will absorb all the common gases when heated to a high temperature, and is therefore used in some radio valves since it functions as its own 'getter' and hardens any vacuum in which it is heated. Other uses of tantalum are for the manufacture of surgical instruments and for electrodes in electrolytic rectifiers for alternating current.

Ultra-Microscopic Viruses infecting Animals and Plants.

IN opening the discussion on ultra-microscopic viruses infecting animals and plants, held at the Royal Society on Feb. 28 and continued on Mar. 14, Sir Charles Martin pointed out that the first virus, that of tobacco mosaic, was discovered by Iwanowski, a Russian botanist, in 1892. Five years later, Lœffler and Frosch ascertained that foot-and-mouth disease of cattle was due to a filter-passing contagium, and since that time numerous virus diseases of plants, mammals, birds, insects, and even bacteria have become known. These show no common clinical or epidemiological features, and simply form a heterogeneous collection of contagia, all filterable with an infective filtrate and with at present no proved microbial connexion. In certain cases distinctive intracellular bodies occur which may be used in diagnosis.

Filterability, which gives entry to the group, depends upon numerous and obscure factors. Viruses may be good or bad filterers, and this is not simply a question of size. That viruses are invisible is merely due to the fact that the finest filters stop particles of about $0{\cdot}1\mu$, whilst the limit of microscopic resolution is about $0{\cdot}2\mu$. The dimensions of virus, probably not less than collargol ($20\mu\mu$), raise the question of the minimum size of living organisms and have suggested the alternative hypothesis that viruses are propagating catalysts. Viruses, however, show the characters of living things and there are no essential distinctions save those of size and cultivability. Even the latter may be due to a size limitation of their powers of assimilation which renders them obligate parasites, a view supported by the absence of any evidence of saprophytic viruses. The study of virus diseases is certainly one of the most important and difficult fields of biology to-day.

Dr. Henderson Smith was prevented by influenza from opening the discussion from the plant side. In his communication he emphasised the fact that viruses causing disease in plants are of the same nature as those causing it in animals. Some plant viruses attack numerous hosts, whilst others are more narrowly adapted. Many viruses can be transmitted by juice or tissue, and these are filterable and highly infective. Others can only be transmitted by grafting, and their filterability cannot be determined. Probably, in the field, all plant viruses are normally transmitted by insects; in certain cases the relation between a vector and a particular virus is highly specific, and in a few it has been definitely proved that the insect becomes infective only after a period has elapsed since feeding upon a diseased host. Such relationships suggest that viruses are some kind of living parasite. The intracellular inclusions in certain plant virus diseases give protein reactions but themselves do not seem to be alive. The claim that virus disease can be originated *de novo* by inoculation of normal tobacco with normal potato has not been confirmed.

Prof. P. A. Murphy emphasised the strong family resemblance between the virus diseases of plants and the difficulties introduced into their study by the fact that many diseases can only be transmitted by grafting or an appropriate insect vector. Viruses are not found outside the plant, and there is no good evidence of their culture *in vitro*. Fungal and bacterial diseases of plants are local, and the fact that virus diseases are systemic possibly indicates that virus is different in nature from bacteria or fungi. Viruses can be attenuated temporarily or permanently; diseases caused are permanent; as a general rule there is no recovery and an attack does not confer immunity. Cases of apparent recovery are probably due to the occurrence of carriers, a widespread phenomenon in plant virus diseases.

Foot-and-mouth disease was discussed by Dr. J. A. Arkwright, who said it is notable for its easy filterability and high virulence in dilution. The virus is not infectible to other animal species until adapted by passage. Infection confers a short immunity, and susceptibility reappears in the same order as the natural susceptibility of different regions in the normal animal. During the immune period the blood contains antibodies. Foot-and-mouth vaccine inactivated by formalin confers immunity in guinea-pigs and resembles the vaccine of killed bacteria in that the action is proportionate to the dosage. The immunity is specific for the three types of foot-and-mouth and also for the formolised vaccine. The properties of the virus do not exclude its bacterial nature, and there is nothing in the available evidence to contradict the idea of its likeness to bacteria. The alternative idea of a metabolic product seems unlikely.

Mr. J. E. Barnard described some of his efforts to improve microscopic technique, and emphasised the increasing difficulties of observational study as the limits of microscopic resolution are approached. His aim is to use light of shorter wave-length, which should make it possible to see characteristics of a body smaller than can be seen by visual light. A recent development is a dark-ground illuminator for ultra-violet rays, whereby it is hoped to reduce the exposures to workable limits. Mr. Barnard showed a number of lantern slides obtained by this method, and in one of bovine pleuropneumonia granules of $0{\cdot}08\mu$ were clearly revealed. He finds that the virus of pleuropneumonia, which consists of vesicles, shows two methods of reproduction, a normal bacillary type and a type quite distinct. In his work on this virus he has cultivated two saprophytes of ultramicroscopic dimensions.

Experiments on insect transmission of plant viruses were described by Dr. Kenneth Smith. He thought that the incubation period which had been found in certain vectors might be the time taken for the passage of the virus from the mouth to the salivary juices. The virus has no effect on the insect, the period for which vectors remain infective varies with the disease, and two years' experiments have given no evidence of inheritance. Lantern slides illustrated his studies of the transmission of potato mosaic to tobacco, and the extraordinary splitting of the virus into a 'needle disease' and an 'aphis disease,' of which the former, but not the latter, may be made lethal to potatoes by rapid transference. As an explanation of these 'two' diseases, Dr. Kenneth Smith suggests that the sap of tobacco contains a substance which reacts with the saliva of the aphis and so modifies the disease.

Dr. W. E. Gye gave an account of his researches on the Rous fowl sarcoma, from which a filter-passing virus may easily be obtained capable of producing true tumours giving further infective filtrates. There is a group of such filterable tumours of diverse structure showing this power of giving rise to unlimited growth. Each gives a filtrate of specific nature. The virus shows the properties of other viruses, and its susceptibility to various antiseptics shows the same general range as other organisms, *e.g.* bacteria. In its susceptibility to acriflavine it is similar to pleuropneumonia virus, and it seems of the same order as this virus and also of the same order as visible bacteria.

Prof. J. C. Ledingham opened the second day's

discussion by summing up the impression left on him by the previous contributions, namely, that viruses appear to be like bacteria in most characters save dimensions, that we have not yet exhausted the possibilities of ordinary microscopic vision in the study of viruses, and that one of the most valuable lines of research is the question of virus attenuation in relation to immunisation. The importance of the latter is shown in vaccinia and variola, where passage makes feasible vaccination which confers a prolonged immunity. With foot-and-mouth and certain other viruses, the killed virus gives a vaccine conferring a brief immunity but the possibilities of virus attenuation have not been sufficiently exploited in these fields. In its attenuation behaviour vaccinia shows inhibitions no different from those of experimental erysipelas, which suggests that the virus resembles visual bacteria. No definite opinion can yet be given regarding the nature of the included bodies, which are of uniform size ($0{\cdot}2\mu$) and behave like staphylococci inoculated under similar conditions. Woodruffe and Goodpasture were able to isolate a single body of fowlpox and found it to consist of innumerable elementary bodies. Regarding the question of concomitant bacteria, for example, *B. sui-pestis* and swine fever, the action seems to be one of activation of the bacterium by the virus in pigs carrying disease.

The more general principles of plant viruses as illustrated in potato mosaic were dealt with by Dr. R. N. Salaman. He has been unable to confirm the American results that virus disease may be caused by physiological disturbance due to the introduction of foreign protoplasm into a plant, and thinks that the original results are due to the use of carrier plants. Questions of carrying and tolerance underlie all plant studies. By inoculation into varieties having different tolerance, it is possible to distinguish viruses producing identical symptoms such as crinkle *A* and *B*. Certain viruses, for example, crinkle, are not altered by passage.

Prof. F. W. Twort considered that, according to the theory of evolution, we should expect forms of life much more primitive than bacteria, and that such primordial stages might be represented by the viruses. Present research methods may not be suitable for the study of such organisms, and entirely new methods are desirable. For example, rays below the infra-red may be essential to the growth of viruses, and work he has carried out with rays of 21-31 metres wavelength has given very promising results.

The differences between bacteria and viruses from the immunological point of view were emphasised by Dr. C. H. Andrewes. The main character of virus immunity is its solid or absolute character, the condition often lasting throughout life and being related, probably, to the persistence of the virus in the tissues. Although viruses inactivated by formalin, etc., confer immunity, it is not possible to immunise or to produce antibodies by heat-killed virus. In the former case the serum of immune animals contains antibodies different from other known antibodies, and the body's defence against viruses is different from that against visible bacteria.

Capt. S. R. Douglas described the electrical behaviour of viruses. In all cataphoretic experiments the virus passes to the positive pole. The distribution of the virus in the blood in the several stages of certain virus diseases was also referred to briefly.

Dr. E. Hindle gave an account of his experiments on the virus of yellow fever. This normally passes moderately coarse filters, but in the mosquito it is arrested even by those of coarsest grain, which suggests the occurrence of an evolutionary process inside the insect's body. Dr. Hindle thought that the undoubted variability shown by viruses indicated an organismal nature, but the character of the immunity conferred was so different from that in bacterial diseases that virus could not be considered as merely very minute bacteria.

Dr. W. B. Brierley emphasised the fact that plant workers give far less value to the character of filterability than do zoological students. In many plant viruses filterability cannot be tested, as the diseases are, under known conditions, not juice-transmissible and can only be transferred by grafting or insect vectors. Plant viruses exist as numerous strains the virulence of which can in many cases be increased or attenuated. Two or more viruses may act in conjunction, producing characteristic diseases which can be analysed and resynthesised experimentally. In insect transmitted diseases one insect may carry different viruses or one virus may be carried by different insects, but in certain cases the relationship between virus and insect is amazingly specific, and in at least one case there is a prolonged 'incubation' period. The systemic character of virus diseases is not distinctive, certain fungal and possibly bacterial plant diseases being systemic. Virus intracellular inclusions have been found in numerous diseased plants, and evidence is accumulating that they are characteristic of particular host-virus relationships. In spite of certain difficult points such as dimensions, and in the case of animals, immunological characters, a survey of the evidence makes it difficult to visualise the viruses as propagating catalysts or as other than organisms of the same order of life as bacteria.

Prof. A. E. Boycott discussed the nature of viruses and briefly summarised views which were published more fully in NATURE of Jan. 19. He considered that in many ways viruses show the character of ordinary bacteria, whilst in other ways they more resemble the unorganised growth-promoting substances and that, as it is all a matter of analogy, which view one accepts depends upon which side one's personal bias tips the scale.

A discussion on 'viruses' is rather like what one would expect a discussion on 'insects' or 'bacteria' to be; something large and fine, but not a little scattered and diffuse. Apart perhaps, from 'the nature of virus,' no coherent thread ran through the contributions. The meetings were valuable, however, in bringing together workers from all the fields of virus research and letting them hear and see each other in the flesh.

The Chemical Society in the Industrial North.

FOLLOWING the precedent established in 1926, when the annual general meeting and anniversary dinner were held in Manchester, the Chemical Society this year visited Leeds on Mar. 21. The proposal to hold such meetings away from London at frequent intervals was one which was immediately commended; the present plan gives many fellows of the Society who for a variety of reasons may find it impossible to travel to London an opportunity of identifying themselves with the activities of the Society, and it also lends an occasion for the greater emphasis, in variously engaged communities, of the part which chemistry plays in modern industry, health, and education, in the modern State, and above all in the world-wide development and maintenance of a friendly rivalry in the service of mankind.

The official business of the Society was first transacted at a meeting held in the Colour Chemistry Department of the University of Leeds. Afterwards, fellows and others assembled in the Great Hall of the University to receive the presidential address. A cordial welcome was extended to the Society by the Vice-Chancellor (Dr. J. B. Baillie) and by the Lord Mayor of Leeds.

In his presidential address, entitled "Co-operation in Science and Industry," Prof. J. F. Thorpe takes stock of the position in which we find ourselves as a result of the stimulus applied by the War in the direction of scientific achievement, of the developments leading to co-operation in various desirable forms, and of the way in which this stimulus and co-operation are being applied to increase the prosperity of Great Britain. It is, as Prof. Thorpe says, chiefly to the chemical and allied industries that the country turns to increase its productive capacity, its capacity to render available the potential wealth of the nation in a suitable form, whereby alone a universally higher standard of living can be made possible. He is convinced that it is organised industry, relying for its political and financial strength on co-operation—those who hold the keys of national prosperity—who will in the future (if they do not already) call the major chords of the political tune, which is not unreasonable, unjust, or even unlikely, seeing that organised industry both makes it possible to pay the piper and fashions his instrument. By organised industry we suppose Prof. Thorpe to mean the body corporate, composed of capital, and management, and 'labour' (that much abused term, by which we will propose to describe every kind of human service except those accounted for as management and capital)—that body corporate which keeps in the closest possible touch with all sources of new knowledge, with all applications of knowledge both old and new, with human needs, and with national policy. Four kinds of co-operation, Prof. Thorpe reminds us, are essential to strength: internal co-operation, co-operation with pure science, co-operation with Government, and co-operation with labour. Leaving aside the last, not because of any lack of importance (indeed, this form was described as being "above all" necessary), but merely because the occasion was unsuitable for its discussion, he presents us with an analysis of ways and means, of results and expectations in the domain of the other opportunities for co-operation.

As a concrete example of internal co-operation he selects the common use of hydrogen in three industrial processes: the production of methyl alcohol, of liquid fuels from coal, and of ammonia. Close association of engineers with chemists has been indispensable in order to render possible the establishment of a group of industries so largely dependent on the inauguration and control of reactions under pressure, and on the still empirical employment of chemical 'lubricants,' as catalysts have, not inaptly, been described. There remain, even in the single field of the hydrocarbon industry, vast areas awaiting co-operative exploration. The co-operation required, however, is not exclusively of the strictly scientific kind. Let us suppose that there is a country in the throes of a crisis in its coal-mining industry, yet importing vast quantities of liquid fuel. It is obviously to the advantage of that country literally to liquefy its assets. Science and industry show us that one promising method of producing oils and numerous other valuable raw materials from coal is afforded by the low-temperature carbonisation process; but, says Prof. Thorpe, albeit in other and more polished phrases, to the unscientific citizens of that country who still burn raw coal on their domestic hearths: no coke, no oil. Again, we are asked to consider the enormous waste of natural gas—millions of cubic feet each day in Canada: twenty-five million cubic feet daily in Persia—and to reflect on what co-operative research might do to utilise it.

Co-operation with pure science is a matter of special moment to our universities, where the human material acquires its knowledge, its impulse, and its outlook, and where opportunities for useful contribution to industrial and national prosperity abound, if only they are made available by support from industrial and national resources. It is, of course, the primary function of the university to attend to fundamentals, both in training and in research; to produce men who are capable of applying their minds with intelligent understanding, with wise vision, with human sympathy, and with appreciation of moral values to the world and its affairs. Prof. Thorpe has special opportunities both to study the inevitable problems and to reach sound conclusions concerning their solution. Discussing the contribution of the universities, so far as co-operation between science and industry are concerned, Prof. Thorpe speaks with experience of the training of the men, pointing out the necessity for research training in order to discover the potential value of a student, and recommending that a higher standard be required of candidates for entry into the honours school. In his remarks on the fundamental research which can be, and is, successfully carried out in the universities, he pays tribute to the far-sighted policy of leading industrial organisations, particularly of Imperial Chemical Industries, Ltd., in affording financial support to enable such studies to be prosecuted under the direction of specialists in various branches of research.

The Government's part in co-operating in science and industry is being exercised in the two most profitable directions in which, in Prof. Thorpe's view, support could be given, namely, on one hand by protection of young and struggling industries, and on the other hand by the promotion of research by means of the establishment of specific inquiry, of financial assistance to industrial groups, and of the provision of research studentships and fellowships. With the present policy of the Department of Scientific and Industrial Research in reducing the number of maintenance grants for students in training Prof. Thorpe expresses dissatisfaction. In fact, he uses words which indicate considerable disquietude: "the outlook is serious"; "it is essential that the State should provide the means for helping to meet this very real national difficulty"; "it is to be hoped that the diminution is merely a temporary expedient." Prof. Thorpe is right in saying that a policy which has provided a steady stream of research workers not otherwise available ought not in any measure to be laid aside while there remains a national need for the best type of research worker. He would be a brave man who would risk his reputation or his roubles in the attempt to prove that the need neither exists in Great Britain to-day, nor is likely to be intensified to-morrow.

In the evening, the anniversary dinner of the Society was held in the Town Hall, the principal guest being Viscount Lascelles, who, in his speech welcoming the Society to the West Riding of Yorkshire, mentioned the special degree to which the prosperity of that part of the country is dependent on co-operation between science and industry. The Lord Mayor of Leeds urged the development of a spirit of collective enterprise, in addition to, rather than instead of, that of private enterprise. The Vice-Chancellor of the University said that the theme of the

address was one which was constantly under discussion in that area; it seemed to him that the practical application of science was often more difficult than the fundamental theoretical considerations, and he described chemistry as a blend of patience, poetry, and penetration. Prof. E. Biilmann declared that national feeling is not incompatible with an international spirit in science, which is the quintessence of internationality, while Prof. Max Bodenstein spoke of the common work and the friendship of the workers.

Electrical Conductivity in Strong Magnetic Fields.

P. KAPITZA has contributed to the *Proceedings of the Royal Society*, dated Mar. 6, two important papers on the change of the electrical conductivity of metals in strong magnetic fields. The first paper is experimental and gives the results of experiments on some thirty-five different kinds of metals, all of which were subjected to enormous magnetic stresses.

In ordinary commercial magnetic testing we rarely go to magnetising forces so high as 50 gauss. In Kapitza's experiments the magnetising forces are taken up to 300,000 gauss. In order to get consistent results, it was found necessary to obtain metals of the greatest purity and to make certain that the metals were all in their normal physical state at the commencement of the experiment. Most of the metals were studied at three temperatures: at room temperature, about 17° C. (290° Kelvin); at a temperature of 193° K., when the Dewar flask containing the metal under test was filled with a mixture of solid carbon dioxide and ether; and finally, at a temperature of 88° K., when the flask was filled with liquid nitrogen. Most of the metals were subjected to both transverse and parallel (longitudinal) magnetic fields.

It was found that in all the metals the change of resistance follows the same law, which can be expressed by a formula which gives good agreement with the experimental results. It shows that in weak fields the resistivity of the metals increases in proportion to the square of the magnetic field, but in stronger fields, up to 300 kilogauss, the increase of resistance is in direct proportion to the magnetic field. It is shown that the physical change produced by hardening or annealing the metals has a great effect on the phenomenon of change of resistance in a magnetic field.

The experimental results indicate that the resistance can be considered as made up of two components, an ideal resistance which is a property of the metal, and an additional resistance which is attributed to internal disturbances. The ideal resistivity has a constant value for each metal at a given temperature, but the additional resistance appears to be independent of the temperature.

Kapitza's researches have a direct bearing on the theory of metallic conduction. He has proved that both in a transverse and in a parallel magnetic field the increase in the resistance of the metal conductor due to the field is directly proportional to the first power of the applied field. His pioneering experiments on the resistance of metals in very intense fields bring this out clearly. Modern theories are based on the assumption that the paths of the free electrons are deflected in their motion by the magnetic field. They lead to the conclusion that the effect must follow a square law. As this is not true, the phenomenon cannot be merely due to the obstruction of the paths of the electrons. Kapitza gives a theory which assumes that the change of resistance follows a linear law with the increasing field. This effect is masked in weak fields by disturbances existing in the metal which are equivalent to that produced by an inside magnetic field. He obtains formulæ which agree with the experimental facts and permit the separation of the ideal resistance and the additive resistance which is produced by internal disturbances.

It has been observed by Kamerlingh Onnes and others that close to the absolute zero of temperature there is a 'residual resistance.' This resistance is the 'additive resistance,' which is independent of the temperature.

The other component of the total resistance, which Kapitza calls the ideal resistance, has a constant value for a given temperature in each metal, and is independent of the chemical and physical state of the metal. Mercury, thallium, tin, lead and indium, which are supra-conductors, were very carefully examined, but no exception to the general law in their change of resistance in magnetic fields was observed. The experiments definitely indicate that the phenomenon of supra-conductivity consists in the disappearance of the additive resistance. The resistance of the conductor is then equal to its ideal resistance. It follows that supra-conductivity is not a phenomenon confined to a few metals, but probably exists in all metals. The temperature, however, has to be reduced sufficiently low to make the additive resistance disappear.

University and Educational Intelligence.

BRISTOL.—One or more research studentships in experimental physics are being offered for the session 1929–30. The emoluments will be from £200 to £300, and the studentships may be renewed for a second or a third year. Further particulars may be obtained from Prof. Tyndall, to whom applications should be sent before May 25.

A studentship in theoretical physics is also offered for the session 1929–30, of the value of from £200 to £300, and the studentship may be renewed for a second or a third year. Further particulars may be obtained from Prof. Lennard-Jones, to whom applications should be sent before May 25.

CAMBRIDGE.—The Amy Mary Preston Read scholarship, of value £150, for research in a scientific subject, has been awarded to H. D. Ursell, scholar of Trinity College. B. H. C. Matthews, Beit Memorial Fellow 1928, has been elected a fellow of King's College.

EDINBURGH.—At a graduation ceremonial on Mar. 21 the degree of doctor of science was conferred on Gwendoline Hilda Faulkner for a thesis on "The Anatomy and the Histology of Bud-Formation in the Serpulid *Filograna implexa*"; on Mr. J. M. Gulland for a thesis on "The Morphine and Aporphine Alkaloids"; and on Mr. T. A. Sprague for a thesis on "Taxonomic Studies in *Loranthus* and other Phanerogamic Genera."

LONDON.—Dr. Paul Dienes, senior lecturer in mathematics at University College, Swansea, has been appointed as from Aug. 1 to the University readership in mathematics tenable at Birkbeck College. Dr. Dienes was educated at the Presbyterian College of Debrecen, Hungary, and the University of Budapest, where he obtained his doctorate in 1905. On graduation he was appointed lecturer in mathematics at Budapest. In 1908 he was given two years' leave of absence to study in Paris and obtained the doctorate of the University

of Paris in 1909. From 1918–19 he acted as adviser to the Commissioner for the re-organisation of the University of Budapest, and in 1919 he organised the Faculty of Science in the new Calvinistic University of Debrecen, Hungary. His publications include " Leçon sur les singularités des fonctions analytiques" (Gauthier-Villars, 1913), " Taylor Series : an Introduction to the Theory of Functions of a Complex Variable " (Oxford Univ. Press, in the press), and numerous papers in French, Hungarian, and Italian scientific journals.

The degree of D.Sc. in anatomy has been conferred on Mr. W. B. Crow (East London College), for a thesis entitled " Contributions to the Principles of Morphology."

An Academic Diploma in Public Health is to be instituted.

OXFORD.—The fifth Annual Report of the Lewis Evans Collection of Scientific Instruments was presented to Congregation on Mar. 19. It contains an interesting note on the original carved panels on either side of the east window of the Old Ashmolean Museum. The carving represents marine shells and exotic fruits, having a direct reference to the use of the Museum for illustrating the natural productions of lands oversea ; an object, as Mr. R. T. Gunther, the curator, points out, always uppermost in the minds of the Tradescants and of Elias Ashmole. The report also records a long list of accessions, and speaks with appreciation of the encouragement derived from the inauguration during the year of a " Society of Friends of the Old Ashmolean."

The electors to the professorship of engineering science propose to proceed to the election of a professor in the course of the ensuing Trinity Term. Applications must reach the Registrar not later than April 27.

THERE will be an election to Beit Memorial junior fellowships in medical research in July next. Forms of application and all information can be obtained on request by letter addressed to Sir James K. Fowler, 35 Clarges Street, W.1. The latest date for the return of application forms is June 1.

APPLICATIONS for a Ramsay Memorial Fellowship for Chemical Research, the annual value of which is £250, with the possible addition of not more than £50 for expenses, should reach the Secretary of the Ramsay Memorial Fellowships Trust, University College, Gower Street, W.C.1, by, at latest, June 5.

APPLICATIONS are invited for scholarships for the promotion of research in sanitary science which have been established by the Grocers Company. The annual value of each scholarship is £300, plus an allowance for expenses, and the tenure is for a year, with a possible extension for a further year or two years. Application forms, returnable before the end of April, may be obtained from the Clerk to the Grocers Company, Grocers' Hall, E.C.2.

THE Board of Regents of the University of the Philippines has established a Baker Memorial Professorship in the College of Agriculture. This professorship, which is in memory of Charles Fuller Baker, who was dean of the College of Agriculture from 1917 until his death in July 1927, provides for the services in the College of a man from abroad who shall be in residence and teaching in the College eight months at least, and it is proposed to secure men who are specialists in the different sciences allied to agriculture.

Calendar of Patent Records.

April 1, 1614.—On April 1, 1614, there was granted to William Ellyott and Mathias Meysey an English patent for the first cementation process for converting iron into steel, and steel was successfully produced by the inventors and by Sir Basil Brooke, to whom the patent was transferred in 1618. A second patent containing extended privileges was granted to Ellyott and Meysey, but a clause in it prohibiting the importation of steel created international complications and the patent was revoked.

April 1, 1773.—It is not often that an invention is considered worthy of a public monument within a year or two of its birth. But this happened in the case of David Hartley's invention for securing buildings against fire by means of thin iron plates laid under each floor and in the ceilings, which was patented on April 1, 1773. The invention was adopted in a number of buildings and received extraordinary support from the Corporation of the City of London, which not only attended officially at a full-scale trial of the invention, but erected an obelisk, which still stands, on Wimbledon Common, and made Hartley a freeman of the City. Parliament, too, was not far behind. It voted £2500 to enable the inventor to carry on his experiments, and extended the duration of the patent for thirty-one years from 1777.

April 2, 1712.—The first specification of an invention to be enrolled in the High Court of Chancery pursuant to a definite proviso in the patent grant was enrolled on April 2, 1712, in connexion with John Nasmith's patent, No. 387, for " the preparing and fermenting of wash from sugar molasses and grain." The wording of the grant shows that the insertion of the proviso, which later became a regular requirement of the Crown, was the suggestion of Nasmith himself. (Cf. this Calendar, Feb. 29 and Mar. 13.)

April 3, 1449.—The patent granted by Henry VI. to John of Utynam on April 3, 1449, for the exclusive right of making coloured glass, is the earliest known example of an industrial monopoly patent in England or any other country. John of Utynam came from Flanders at the King's command to make windows for colleges at Eton and Cambridge, and the grant recites that because the said art had never been used in England, and John intends to instruct divers lieges of the King in its practice, no subject of the King is to use it for a term of twenty years, against the will and consent of John, under a penalty of £200.

April 4, 1785.—One of the outstanding inventions of the eighteenth century—the power loom—was patented by the Rev. Edmund Cartwright on April 4, 1785. Neither this nor his other patents brought much reward to the inventor, but he received a special parliamentary grant in 1809 in recognition of his services to industry.

April 5, 1839.—Josiah Marshall Heath's patent, dated April 5, 1839, for the first practical process for the manufacture of manganese steel, gave rise to one of the hardest fought law-suits in the annals of British patent law. During the protracted proceedings the case at one time or another came before no fewer than 18 different judges—of whom 7 decided in favour of the patentee and 10 against—as well as the Privy Council and the House of Lords, and the final verdict of the latter was not delivered until 1855, thirteen years after the commencement of the suit and after the death of Heath himself. The value of the invention to industry was not in question, and the Privy Council recommended the extension of the grant for seven years, but this decision was rendered nugatory and the case brought to a close by the final judgment of the House of Lords against the inventor.

Societies and Academies.

LONDON.

Geological Society, Mar. 6.—**Mrs. M. M. Ogilvie Gordon**: Structure of the Western Dolomites. She described briefly the stratigraphical succession of the Permian and Triassic rocks which mainly compose the mountain lands of the Western Dolomites, and showed their character in a number of photographic slides. Special attention was given to the outbreaks of volcanic action which took place in the Upper Buchenstein and Wengen periods at the close of the Alpine Middle Trias. The leading structural features were described, with the aid of the geological map of the Gröden and Fassa district published by the lecturer in 1927.

Institute of Metals, Mar. 14.—**W. Rosenhain** and **W. E. Prytherch**: An improved form of electric resistance furnace. Higher available working temperatures (up to 1400° C.), durability, and freedom from oxidation of the carbon resistor are claimed. The heating element consists of carbon or graphite pellets, or short rods placed end to end in a refractory sheathing tube which fits easily over them. Heating occurs by contact resistance. The sheathing tube prevents the access of air sufficiently to avoid any appreciable burning of the carbon.—**C. Sykes**: Alloys of zirconium (2). Measurements of electrical and magnetic properties of copper-zirconium, iron-zirconium, and nickel-zirconium alloys show that zirconium gives no material improvement in the properties of the metals, and in certain cases is detrimental. Two further partial series of binary alloys are described—aluminium-zirconium and silver-zirconium. The systems exhibit little solubility in the solid state at room temperatures and intermetallic compounds are formed. In the low-percentage alloys (10 per cent) the compounds crystallise in the form of long, fine needles, and consequently the structure of the alloys is very coarse.—**J. Newton Friend** and **W. E. Thorneycroft**: The resistance of zinc to indentation (a preliminary account). A machine is described for determining the rate of indentation of zinc by a steel conical die acting under small gravity loads.—**J. Newton Friend**: The solution of plain and amalgamated zincs in electric batteries. For use in electric batteries with dilute sulphuric acid or with saturated ammonium chloride solutions, plain high-grade 99·9 per cent zinc cannot satisfactorily replace the amalgamated metal or amalgamated pure zinc.—**J. Newton Friend** and **W. E. Thorneycroft**: The silver contents of specimens of ancient and medieval lead. Twenty specimens of ancient, Roman, and medieval lead have been analysed. Spartan lead votive figurines, *c.* 700–500 B.C., contain 0·0568 per cent silver, or 18½ oz. silver per ton. The pre-Roman lead does not appear to have undergone any treatment for desilverisation.

CAMBRIDGE.

Philosophical Society, Mar. 11.—**N. F. Mott**: The quantum theory of electronic scattering in helium. Born's calculation of the electron scattering in atomic hydrogen is extended to the case of helium. The results agree well with experiments of Dymond and Watson.—**H. M. Cave**: Note on the number of high velocity β-rays. By a simple magnetic field method, it is shown that, for radium B + C, the number of β-rays having energies greater than 12,000 $H\rho$ must be less than 1 per 500 disintegrations, and is probably less than 1 per 1000 disintegrations.—**J. L. Hamshere**: The mobility distribution and rate of formation of negative ions in air. The Rutherford-Frank-Lattey 'alternating field' method of measuring ionic mobilities in a gas has been modified. Negative ions in dry air have a continuous mobility distribution between the limits 2·15, 1·15, with a peak value about 1·8. At pressures below 50 mm. (Hg) the current is resolved into ions and free electrons. The ratios of the ion and electron currents show that the electron makes in air a mean number of $9 \cdot 4 \times 10^4$ collisions before capture, independent of electron velocity over a range 2 to 7×10^5 cm./sec.

DUBLIN.

Royal Irish Academy, Feb. 25.—**Miss M. C. Knowles**: The lichens of Ireland. In the arrangement of the list, Praeger's topographical divisions are used and the classification and nomenclature of the "Monograph of British Lichens." 801 species are recorded; among them 7 new to science and 5 to the lichen flora of the British Isles.—**Rev. R. J. Doyle** and **H. Ryan**: Periodic precipitation in the presence and absence of colloids. The equation of Jablczynski giving the relation between the distances of bands formed during periodic precipitation in the presence of colloids, and also the equation of Morse and Pierce, hold approximately for the banded precipitation of calcium hydrogen phosphate in the absence of colloids. The presence of the colloid cannot therefore be the main factor in the phenomenon. It was also shown by means of indicators in gels that the diffusing reagent is far in advance of a point at which a band begins to form. The colour changes of the indicators showed clearly that band formation does not occur in the diffusing wave front as some theories of periodic precipitation appear to assume.

PARIS.

Academy of Sciences, Feb. 18.—**L. Lecornu**: The Clapeyron cycle in the case of saturated vapours.—**H. Douvillé**: The Western Pyrenees at the commencement of the Eocene and the formation of the chain.—**V. Grignard** and **Tchéoufaki**: The additive properties of the α-diacetylenic hydrocarbons. Oxidation with weak (1-2 per cent) potassium permanganate solution in acid solution gives a product of hydration and not of oxidation: stronger solutions (5-6 per cent) give oxidation products. The addition of water (sulphuric acid, mercuric chloride) gives always a β-diketone. Shaking with oxygen gives partial hydration.—**T. Nagell**: The rings of algebraic integers.—**A. Khintchine**: A generalisation of some classical formulæ.—**L. Lusternik** and **L. Schnirelmann**: The existence of three geodesics closed on the whole surface of genus 0.—**Th. Anghelutza**: A new class of nuclei for a Fredholm equation.—**Vladimir Bernstein**: The singular points of functions represented by Dirichlet's series.—**Jacob**: The application of Fourier's generalised integrals to the calculus of probabilities.—**N. Neronoff**: A continuous irrotational movement in two dimensions of an indefinite fluid in the presence of a fixed cylindrical obstacle.—**Pierre Dupin**: A new method of measuring the velocity of fluids based on the use of valve oscillators. A description with illustrations of an apparatus showing the velocity of a fluid by a direct reading on a graduated scale. It is based on the modification of the wave-length of an oscillating circuit produced either by a variation of capacity or by a variation of the self-induction of the circuit under the influence of the velocity of the fluid. The condenser readings are a linear function of the velocity.—**Benjamin Jekhowsky**: The corrections of the ephemerids of the minor planets.—**A. Véronnet**: The origin of the planets and the formation of the world.—**Y. Rocard**: Hydrodynamics and the kinetic theory of gases. The wall limiting the fluid absorbs molecules

and sends them out according to a law of distribution of velocities other than that of Maxwell. Near the wall of the vessel the gas or liquid is no longer a fluid and the equations of hydrodynamics are not satisfied. At distances greater than three or four times the mean free path, the ordinary laws of fluids hold.—**Jean J. Trillat**: The orientation of organic compounds by cylindrical glass surfaces and the superficial orientation of the glass.—**Ballay**: The cathode yield in the deposition of nickel with high current densities. The influence of oxidising agents and of the hydrogen ion concentration.—**Pierre Bonnet**: The tectonic structure of southern Transcaucasia.—**Kadlec-Fleck**: The synthesis of cyanamide by combinations of carbon and calcium nitride. Calcium nitride reacts with carbon at a red heat, giving cyanamide and calcium carbide. Between 800° C. and 1100° C. the rapidity of the reaction increases with the temperature. Above 1000° some calcium cyanide is also produced.—**Luigi Umberto de Nardo**: A new method of colorimetric estimation of nitrates in soils and waters. This method is based on the use of pyrogallolsulphonic acid as reagent.—**Aug. Chevalier** and **W. Russell**: The subfamily of Erisma.—**P. Mazé**: The mean temperature of the leaves of maize exposed to sunlight.—**Lucien Daniel**: The heredity of the ligneous transformations in the descendants of grafted Jerusalem artichoke and sunflower.—**Raymond Poisson**: The presence in the south of France of an American Hemipter-homopter of the family of the Membracidæ, *Ceresa bubalus*, and its biology. This insect, which seriously affects certain cultivated plants, was noted in France (Eastern Pyrenees) in 1927, and its possible extension must be watched.—**F. Maignon** and **A. Painvin**: The influence of the seasons on the respiratory combustions of the dog.—**Pierre Marié**: The arthropods inhabiting the burrows of the Alpine marmots.—**E. Aubel**: The relation between the production of lactic acid and the growth of yeast.—**M. Javillier** and **Mlles. S. Rousseau** and **L. Emerique**: The chemical composition of the tissues in A-avitaminosis: phosphorus, lipoid extract, cholesterol.—**Mlle. A. Michaux**: The total albumens (seroalbumen or serine and serumglobulin) of the serum of guinea-pigs suffering from scurvy. The presence of albumen and hæmoglobin in the urine of animals at the end of the disease.—**E. Wollmann** and **Ach. Urbain**: The reaction of fixation in grafted tumours of mice.—**R. Douris, Ch. Mondain** and **Mlle. M. Plessis**: The differentiation of normal and pathological sera. The oxidisability of the sera. The diluted sera were oxidised by a chromic-sulphuric acid mixture under comparable conditions. The oxidation coefficient, expressed as oxygen absorbed, was least for cancerous sera, higher for syphilitic sera, and highest for normal sera. The coefficients overlap to an extent which deprives the method of diagnostic value.

SYDNEY.

Royal Society of New South Wales, Dec. 5.—**A. R. Penfold** and **F. R. Morrison**: The chemistry of the exudation from the wood of *Pentaspodon Motleyii*. This tree occurs in New Guinea and is identified as close to *Pentaspodon Motleyii*. The crude oil was non-volatile in steam and could not be distilled without decomposition at 1 mm. It contained 90-95 per cent of a new monocarboxylic acid of molecular formula $C_{24}H_{36}O_4$. The silver and copper salts are the only two derivatives which have so far been prepared.—**A. R. Penfold**: The essential oil from a pinnate leaf *Boronia* from Frazer Island, Queensland. The oil contains 75-80 per cent safrol, limonene, etc. It differs in composition from all other pinnate leaf *Boronias* so far described, and on account of the inability of botanists to separate it from *B. thujona* it is known tentatively as *B. thujona, var. A.*—**M. B. Welch**: Examination of defective oregon. An investigation was made on portion of an electric crane which broke suddenly in Sydney. The wood used was oregon, and mechanical tests showed that the wood was extremely brittle and unable to absorb energy due to sudden shocks. Usually wood is far stronger in tension than in compression, but with the timber in question there was little difference in this respect. It seems possible that, due to continual reversal of the stresses in the member, the wood had become fatigued.—**W. R. Browne**: The probable Tertiary age of certain New South Wales soils. It is agreed that accumulation of residual sedentary soils is favoured by low physiographic relief; consequently, when such deposits are found in regions of high relief, they may be regarded as relics from the latest stages of the cycle of erosion immediately preceding. Some soils occurring around Sydney, on the Blue Mountains, and elsewhere on the highlands, are believed to have been produced during the Tertiary peneplanation; one indication of this is found in the ironstone gravel or hardpan which is so frequent in these soils and must have been formed under physiographic and climatic conditions very different from those prevailing at the present day.—**A. R. Penfold**: The essential oil of a new species of Anemone leaf *Boronia*, rich in ocimene.—**W. R. Browne**: On some aspects of differential erosion. Examples are given from New South Wales illustrating the effect. An explanation is developed of anomalous behaviour of rock-masses in regard to erosion, whereby rocks like granite, really resistant to mechanical wear, are eroded more quickly than less resistant ones. These masses may, during the last phases of the preceding cycle of erosion, have suffered deep and thorough decay, so that on the uplift of the region they succumbed very quickly to river-attack.—**E. Cheel**: Further notes on the genus *Boronia*. Some of the specimens dealt with were collected about eighty years ago by Allan Cunningham and other explorers who considered them to be good species, but several of these were reduced to mere forms or varieties by Bentham. Seven of the earlier names are worthy of rehabilitation to specific rank, and two are proposed as new species.—**W. R. Browne** and **H. P. White**: Alkalisation and other deuteric phenomena in the saddleback trachybasalt at Port Kembla. The changes were produced partly by residual solutions, but mainly by post-volcanic solutions, which have given rise to zones of progressive alteration roughly parallel to the intrusive contact, the greatest changes being in the intrusive rock. These solutions introduced much soda and potash, the former entering into replacive ablite and the latter partly into sericite, but there is chemical evidence that most of the potash is contained in the albite. The term 'alkalisation' is proposed to cover cases of magmatic alteration wherein both alkalis are introduced, or in which either base appears in more than one deuteric mineral.—**G. L. Windred**: Notes on some organisms of tomato pulp. Counts of micro-organisms occurring in commercial tomato pulp revealed the presence of large numbers of various species of moulds, yeasts, and bacteria. An organism causing sliminess of the pulp was isolated; it resembled *Bacillus ruminatus* Gottheil, but there are marked differences. Gas production in sealed metal cans causing the bursting of the containers is due to: (1) production of gas from carbohydrates by the organisms, (2) and the action of the acid produced by them on the metal of the container.—**M. B. Welch**: Notes on some Australian timbers of the Monimiaceæ. The genera described are *Doryphora, Atherosperma, Daphnandra, Mollinedia,* and *Hedycarya*. The vessels show scalariform end per-

forations, and are usually very long. The wood fibres have more or less bordered pits, and reach a maximum length of almost 3·0 mm. in *Doryphora sassafras*. A key is given for the identification of the woods, based on the microscopical characters.—**C. Chilton**: Note on a fossil shrimp from the Hawkesbury Sandstones.

Official Publications Received.

BRITISH.

Journal of the Manchester Egyptian and Oriental Society. No. 14. Pp. 72. (Manchester: Manchester University Press.) 7*s*. 6*d*. net.

University of Leeds. Twenty-fourth Report, 1927-28. Pp. 164. (Leeds.)

Government of India: Department of Industries and Labour (Public Works Branch.) Triennial Review of Irrigation in India, 1924-27. Pp. ii+58. (Calcutta: Government of India Central Publication Branch.) 1 rupee; 1*s*. 9*d*.

Transactions of the Royal Society of Edinburgh. Vol. 56, Part 1, No. 6: A Contribution to Actinian Morphology; The Genera *Phellia* and *Sagartia*. By Dr. T. A. Stephenson. Pp. 121-139+2 plates. 4*s*. Vol. 56, Part 1, No. 7: A Gravitational Survey over the Buried Kelvin Valley at Drumry, near Glasgow. By Dr. W. F. P. McLintock and Dr. J. Phemister. Pp. 141-155+2 plates. 3*s*. 6*d*. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

The Journal of the Royal Horticultural Society. Edited by F. J. Chittenden. Vol. 54, Part 1, January. Pp. 252+lxxxiv+xxiv+94 plates. (London.) 7*s*. 6*d*.

Association of Technical Institutions. Agenda Paper and Report of Council (1928) for the Annual General Meeting to be held on Friday, February 22nd, and Saturday, February 23rd, 1929, at the Grocers' Hall, London, E.C.2. Pp. 46. Draft of Paper to be read at the Annual General Meeting, February 22nd and 23rd, 1929, on "The Relation of Broadcasting to Further Education." By C. A. Siepmann. Pp. 18. Draft of Paper to be read at the Annual General Meeting, February 22nd and 23rd, 1929, on "Technical Training for Women." By Miss Ethel E. Cox. Pp. 10. Draft of Paper to be read at the Annual General Meeting, February 22nd and 23rd, 1929, on "Industrial Safety." By Sir Gerald Bellhouse. Pp. 10. (London.)

Teachers and World Peace: a Memorandum for the Guidance of Teachers who desire to explain the Aims and Work of the League of Nations in Schools. Second edition. Pp. 96. (London: League of Nations Union.) 6*d*.

The Carnegie Trust for the Universities of Scotland. Twenty-seventh Annual Report (for the Year 1927-28) submitted by the Executive Committee to the Trustees on 13th February 1929. Pp. iv+168. (Edinburgh.)

The Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 67, No. 386, February. Pp. 217-316+xxxvi. (London: E. and F. N. Spon, Ltd.) 10*s*. 6*d*.

The South-Eastern Naturalist and Antiquary: being the Thirty-third volume of Transactions of the South-Eastern Union of Scientific Societies, including the Proceedings at the Thirty-third Annual Congress, held at Rochester, 1927. Edited by A. F. Ravenshear. Pp. lxxv+148. (London.)

The Imperial Forestry Institute, University of Oxford. Fourth Annual Report, 1927-28, and Prospectus. Pp. 19. (Oxford.)

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 38: The Chemical Composition of Wool, with Special Reference to the Protein of Wool-fibre (Keratin). By Hedley R. Marston. Pp. 36. Bulletin No. 39: The Utilization of Sulphur by Animals, with Especial Reference to Wool Production. By Hedley R. Marston and Prof. T. Brailsford Robertson. Pp. 51. (Melbourne: H. J. Green.)

The Engineer Directory and Buyers Guide, 1929. Pp. 256. (London: *The Engineer*.)

Canada. Department of Mines: Geological Survey. Economic Geology Series, No. 5: Oil and Gas in Western Canada. By G. S. Hume. (No. 2138.) Pp. v+152. 25 cents. Summary Report, 1927, Part C. (No. 2171.) Pp. 124C. National Museum of Canada, Bulletin No. 50: Annual Report for 1926. Pp. 126+19 plates. (Ottawa: F. A. Acland.)

Report of the Canadian Arctic Expedition, 1913-18. Vol. 15: Eskimo Language and Technology. Part A: Comparative Vocabulary of the Western Eskimo Dialects. By D. Jenness. (Southern Party, 1913-16.) Pp. 134. (Ottawa: F. A. Acland.)

Agricultural Research Council. Reports on the Work of Research Institutes in Great Britain, 1927-1928. (Council Paper No. 90.) Pp. 128. (London: Ministry of Agriculture and Fisheries.)

Nigeria. Seventh Annual Bulletin of the Agricultural Department, 1st August 1928. Pp. 225. (Lagos: Government Printing Office; London: The Crown Agents for the Colonies.) 5*s*.

Royal Society of Arts, John Street, Adelphi, London, W.C. Fund for the Preservation of Ancient Cottages. First Annual Report presented at a General Meeting held on February 27th, 1929. Pp. 24. (London.)

India: Meteorological Department. Scientific Notes, Vol. 1, No. 1: A Comparison of Upper and Gradient Winds at Agra and Bangalore. By Mohammad Ishaque. Pp. 11+7 plates. 1.3 rupees; 2*s*. Scientific Notes, Vol. 1, No. 2: An Analysis of the Madras Hourly Rainfall Records for the Years 1865 to 1875 and 1901 to 1917. By V. Doraiswamy Iyer. Pp. 13-24+1 plate. 9 annas; 1*s*. Scientific Notes, Vol. 1, No. 3: Thunderstorms of Calcutta, 1900-1926. By V. V. Sohoni. Pp. 25-36+4 plates. 14 annas; 1*s*. 3*d*. (Calcutta: Government of India Central Publication Branch.)

War Office. Report on the Health of the Army for the Year 1927. (Vol. 63.) Pp. iv+144. (London: H.M. Stationery Office.) 4*s*. 6*d*. net.

The Costing of Chemical Manufacturing Processes. By L. Stanforth. Pp. 24. (London: The Institute of Chemistry.)

Department of Agriculture, Madras. Bulletin No. 91: A Soil Survey of the Malabar District. By B. Viswa Nath and T. S. Ramasubramanyan. Pp. 9+18 maps. (Madras: Government Press.) 1.6 rupees.

The British Chemical Plant Manufacturers' Association. Official Directory of Members, 1929; with a Classified List of their Manufactures and Services. Pp. 119. (London.)

Transactions of the Geological Society of South Africa. Vol. 31, January-December 1928. Pp. 166+24 plates. 42*s*. Proceedings of the Geological Society of South Africa: containing the Minutes of Meetings and the Discussions on Papers read during 1928; to accompany Vol. 31 of the Transactions, January-December 1928. Pp. iii+lvi. (Johannesburg.)

Transactions of the Optical Society. Vol. 30, 1928-29, No. 1. Pp. 48. (London.) 10*s*.

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1169 (Ae. 333): The Distribution of Pressure over the Hull and Fins of a Model of the Rigid Airship R 101, and a Determination of the Hinge Moments on the Control Surfaces. By Dr. R. Jones and A. H. Bell. (T 2305.) Pp. 37+13 plates. 1*s*. 9*d*. net. No. 1184 (Ae. 347): Experiments on a Model of a Single Seater Fighter Aeroplane in connection with Spinning. By H. B. Irving and A. S. Batson. (T. 2611.) Pp. 19+12 plates. 1*s*. net. No. 1187 (Ae. 349): On the Use of a Follow up Mechanism in Aerodynamic Servo Control Systems. By H. M. Garner and K. V. Wright. (T. 2637.) Pp. 8+2 plates. 6*d*. net. (London: H.M. Stationery Office.)

Department of Scientific and Industrial Research. Third Report of the Gas Cylinders Research Committee (Alloy Steel Light Cylinders). Pp. iii+74+13 plates. 2*s*. 6*d*. net. Fourth Report of the Gas Cylinders Research Committee (Cylinders for Liquefiable Gases). Pp. v+151. 4*s*. net. (London: H.M. Stationery Office.)

Memorandum showing the Progress and Development in the Colonial Empire and in the Machinery for dealing with Colonial Questions from November 1924 to November 1928. (Cmd. 3268.) Pp. 81. (London: H.M. Stationery Office.) 1*s*. 6*d*. net.

The Journal of the Institute of Metals. Vol. 40. Edited by G. Shaw Scott. Pp. xii+877+38 plates. (London.) 31*s*. 6*d*. net.

Aeronautics. Technical Report of the Aeronautical Research Committee for the Year 1927-1928 (with Appendices). Vol. 1: Aerodynamics (Model and Full Scale). Pp. viii+431+ix-xxiii+182 plates. 15*s*. net. Vol. 2: Stability and Control, Autogiros, Materials, Engines, etc. Pp. viii+433-946+ix-xv+187 plates. 20*s*. net. (London: H.M. Stationery Office.)

Proceedings of the Royal Physical Society for the Promotion of Zoology and other Branches of Natural History, Session 1927-28. Vol. 21, Part 4. Pp. 159-216. (Edinburgh.) 6*s*.; to Fellows, 5*s*.

Department of Agriculture, Tanganyika Territory. Pamphlet No. 2: A Planters' Guide to the Production of Arabian Coffee. By A. E. Haarer. Pp. 31. (Dar-es-Salaam.)

The Daylight Transmission of Wireless Waves over Sea Water. By R. O. Cherry. Pp. 8. (Melbourne: Broadcasting Co. of Australia.)

Publications of the Dominion Astrophysical Observatory, Victoria, B.C. Vol. 4, No. 10: The Composite Stellar and Nebular Spectrum of Z Andromedae. By H. H. Plaskett. Pp. ii+119-160. Vol. 4, No. 11: The Orbits of A Persei and H. R. 8210. By W. E. Harper. Pp. 161-168. (Ottawa: F. A. Acland.)

Records of the Indian Museum. Vol. 30, Part 3, October 1928. Pp. 217-373+plates 8-11. 2.12 rupees; 5*s*. Vol. 30, Part 4, December 1928. Pp. 375-468+plates 12-14. 2.12 rupees; 5*s*. (Calcutta: Zoological Survey of India.)

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1172 (Ae. 336): The Effect of Wind, Weight and Atmospheric Conditions (including Semi-Tropical Conditions) on the Distance to Take-off and Land an Aircraft. By Flight Sergt. B. H. Rolles and H. L. Stevens. (T. 2620: T. 2640 and a.) Pp. 14+7 plates. (London: H.M. Stationery Office.) 9*d*. net.

University College of Wales, Aberystwyth. New Varieties and Strains from the Welsh Plant Breeding Station. No. 1: Pure Lines of Hen Gymro Wheat. Selections made by T. J. Jenkin. (Leaflet Series S, No. 1.) Pp. 16+6 plates. (Aberystwyth.) 1*s*.

University of Bristol. Lewis Fry Memorial Lectures, 1928-29. Science and Drama. Lectures delivered by Prof. C. Lloyd Morgan on November 15th and 16th, 1928, in the Great Hall of the University. Pp. 38. (Bristol.)

Armstrong College, Newcastle-upon-Tyne. Standing Committee for Research. Report for 1927-1928. Pp. 28. (Newcastle-upon-Tyne.)

Proceedings of the Royal Irish Academy. Vol. 38, Section A, Nos. 4, 5: Recombination of Ions in Atmospheric Air. Part 1: Investigation of the Decay Coefficient by Schweidler's Method, by Dr. P. J. Nolan and Cilian O'Brolchain; Part 2: The Law of Recombination of Ions and Nuclei, by Dr. P. J. Nolan. Pp. 40-59. 6*d*. Vol. 38, Section B, No. 9: The Pre-Glacial Topography of the Liffey Basin. By Anthony Farrington. Pp. 148-170+plates 6-7. 1*s*. Vol. 38, Section B, Nos. 10, 11: The Condensation of Aldehydes with Nitro-Diacetoresorcinol, by Dr. Joseph Algar and Nora M. MacDonnell; Dichalkones derived from Diacetoresorcinol, by Dr. Joseph Algar and Patrick J. Hanlon. Pp. 171-178. 6*d*. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

The Textile Institute. List of Members and Lists of Fellows and Associates as at 31st January 1929. Pp. 64. (Manchester.)

Proceedings of the Royal Society. Series A, Vol. 123, No. A791, March 6, 1929. Pp. 372. (London: Harrison and Sons, Ltd.) 12*s*.

Journal of the Royal Statistical Society. New Series, Vol. 92, Part 1. Pp. 162+xii. (London.) 7*s*. 6*d*.

Final Report of the Committee on Industry and Trade. (Cmd. 3282.) Pp. vi+338. (London: H.M. Stationery Office.) 5*s*. 6*d*. net.

FOREIGN.

Report of the Danish Biological Station to the Board of Agriculture. No. 34, 1928. Pp. 125. (Copenhagen: C. A. Reitzel.)

Carnegie Institution of Washington. Year Book No. 27, July 1, 1927, to June 30, 1928; with Administrative Reports through December 14, 1928. Pp. xix+438. (Washington, D.C.: Smithsonian Institution.)

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Bulletin of the Interior: Bureau of Education. Bulletin, 1928, No. 13: Major Trends of Education in other Countries. By James F. Abel. Pp. 48. (Washington, D.C.: Government Printing Office.) 10 cents.

State of Illinois. Department of Registration and Education: Division of the Natural History Survey. Bulletin, Vol 17, Art. 5: Some Properties of Oil Emulsions influencing Insecticidal Efficiency. By L. L. English. Pp. 233-259. Bulletin, Vol. 17, Art. 6: Some Causes of Cat-facing in Peaches. By B. A. Porter, S. C. Chandler, R. F. Sazama. Pp. 261-275. Bulletin, Vol. 17, Art. 7: The Biological Survey of a River System—Its Objects, Methods and Results. By Stephen A. Forbes. Pp. 277-284. Bulletin, Vol. 17, Art. 8: The "Knothead" Carp of the Illinois River. By David H Thompson. Pp. 285-320. Bulletin, Vol. 17, Art 9: Methods and Principles for Interpreting the Phenology of Crop Pests. By L. R. Tehon. Pp. 321-346. Bulletin, Vol. 17, Art 10 An Account of Changes in the Earthworm Fauna of Illinois and a Description of one new Species. By Frank Smith. Pp. 347-362. Bulletin, Vol. 17, Art. 11: The Hessian Fly and the Illinois Wheat Crop. By W. P. Flint and W. H. Larrimer. Pp. 363-385. (Urbana, Ill.)

Scientific Papers of the Institute of Physical and Chemical Research. No. 171: Researches on Hypoglycemia producing Substances. 1: Syntheses of certain Guanidine Derivatives. By Taizo Kumagai, Sin-iti Kawai, Yoshio Shikinami and Tatsuo Hosono. Pp. 271-275. 15 sen. No. 173: On the Potentiometric Titration of Gallium. By Sunao Ato. Pp. 5. 15 sen No. 174: On the Oxidation of Stannous Chloride in Sulphuric Acid Solution by Air, and the Dissolution Velocity of Oxygen into Sulphuric Acid Solution. By Susumu Miyamoto. Pp. 7-17. 20 sen. No. 175: The Residual Thermoelectricity of Mercury Filament. By Toshimasa Tsutsui. Pp. 19-32. 25 sen. (Tōkyō: Iwanami Shoten)

Bernice P. Bishop Museum. Bulletin 55: Fringing and Fossil Coral Reefs of Oahu. By James B. Pollock. Pp 56+6 plates. (Honolulu)

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol 80. The Distribution and Habits of the Birds of the Republic of Haiti, by James Bond; On the Birds of Dominica, St. Lucia, St. Vincent, and Barbados, B W.I., by James Bond. Pp. 483-545. (Philadelphia, Pa.)

Collection des travaux chimiques de Tchécoslovaquie. Rédigée et publiée par E. Votoček et J Heyrovský sous le patronage de la Regia Societas Scientiarum Bohemica. Année 1, No. 2, Février. Pp. 65-136. (Prague.)

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Department of Commerce: U.S. Coast and Geodetic Survey. Special Publication No. 151: Comparison of Old and New Triangulation in California. By William Bowie. Pp. iii+50. (Washington, D.C.: Government Printing Office.) 15 cents.

Supplement 33rd to the Bulletin of Applied Botany, of Genetics and Plant-Breeding. Agricultural Afghanistan. (Composed on the Basis of the Data and Materials of the Expedition of the Institute of Applied Botany to Afghanistan) By Prof. N. I. Vavilov and D D. Bukinich. Pp. iii+610+xxxii+28 plates. (Leningrad) In Russian, with summary in English.

Bulletin of the Pacific Ocean Scientific Fishery Research Station Vol. 2, Part 1: Physico-chemical Characteristic of Breeding Migration Fast of Keta Salmon. By Prof. B. P Pentegoff, U. N. Mentoff and E. F. Kurnaeff. Pp. 69. In Russian, with summary in English. Vol 2, Part 2: Algae maris Japonensis; Chlorophyceae. By E. S. Sinova. Pp. 52. In Russian, with résumé in French. (Vladivostock.)

University of Illinois: Engineering Experiment Station Bulletin No 188: Investigation of Warm-Air Furnaces and Heating Systems, Part 3 Conducted by the Engineering Experiment Station, University of Illinois, in cooperation with the National Warm-Air Heating Association. By Prof. Arthur C. Willard, Prof. Alonzo P. Kratz and Prof. Vincent S. Day. Pp. 82. (Urbana, Ill.) 45 cents.

Bulletin of the Peking Society of Natural History. Vol 2, Part 3: Enumeration of Plants collected by the late Mr. Nathaniel Harrington Cowdry in Chihli Province (and Chefoo); (including Contributions made by Dr. Bernard E. Read, Mr. Joseph Hers, Mrs. A. B. D Fortuyn and Mr. J. C. Liu to the Herbarium of the Peking Union Medical College). By Liu Ju-Ch'iang Pp. x+47-194. 2 dollars. Vol 3, Part 2: A Compendium of Minerals and Stones used in Chinese Medicine from the Pen T'sao Kang Mu, Li Shih Chen, 1597 A D Compiled by B. E. Read and C. Pak. Pp vii+120. 1.50 dollars. (Peking.)

Astronomische Abhandlungen der Hamburger Sternwarte in Bergedorf. Band 4, No. 1: Beitrag zur Geschichte und Theorie der astronomischen Instrumente mit rotierendem Planspiegel und fester Reflexrichtung (Heliostat, Siderostat, Zölostat, Uranostat) Von Wilhelm Hartmann. Pp. 36. (Bergedorf.)

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Berichte über die Verhandlungen der Sächsischen Akademie der Wissenschaften zu Leipzig: Mathematisch-physische Klasse. Band 80, No 5. Pp. 273-356. (Leipzig: S. Hirzel) 3 gold marks.

Abhandlungen der Mathematisch-physische Klasse der Sächsischen Akademie der Wissenschaften. Band 40, No. 3: Beziehungen zwischen Lichtbrechung, Dichte und chemischer Zusammensetzung in der Granatgruppe. Von H. v. Philipsborn Pp iii+43. 2.50 gold marks. Band 40, No. 4: Über jungdiluviale und alluviale Torflager in der Grube Marga bei Senftenberg (Niederlausitz). Von F. Firbas und R. Grahmann. Pp. iii+63+2 Tafeln. 3.60 gold marks. (Leipzig: S. Hirzel.)

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Department of the Interior: Bureau of Education. Bulletin, 1928, No. 22: Bibliography of Research Studies in Education, 1926-1927. Pp. vii+162. (Washington, D.C.: Government Printing Office.) 25 cents.

Ministry of Agriculture, Egypt: Technical and Scientific Service: Bulletin No. 79: The Temperature of Cultivated Soil at Giza. By W S Gray and A. A. Nassar. Pp. ii+12+17 plates. 5 P.T. Bulletin No. 80: Sand-Sowing in Cotton-Breeding. By Gadallah Aboulela. Pp. 19. 5 P.T. (Cairo: Government Publications Office)

Bulletin of the American Museum of Natural History. Vol. 56, Art. 8: Pleistocene Mammalian Fauna of the Seminole Field, Pinellas County, Florida By George Gaylord Simpson. Pp. 561-599. Vol. 56, Art. 9: A Revision of the Tertiary Multituberculata. By Walter Granger and George Gaylord Simpson Pp 601-676. (New York City.)

Department of Commerce: Bureau of Standards. Miscellaneous Publication No. 86: Tables of Spectral Energy Distribution and Luminosity for Use in Computing Light Transmissions and relative Brightnesses from Spectrophotometric Data. By J. F. Skogland. Pp. 23. (Washington, D C: Government Printing Office.) 10 cents.

Occasional Papers of the Bingham Oceanographic Collection, Peabody Museum of Natural History, Yale University. No. 2: A Contribution to the Osteology and Classification of the Orders Iniomi and Xenoberyces; with Description of a new Genus and Species of the Family Scopelarchidae from the Western Coast of Mexico; and some Notes on the Visceral Anatomy of Rondeletia. By Albert Eide Parr. Pp. 45 (New Haven, Conn.)

Zentralanstalt für Meteorologie und Geodynamik. Publikation Nr. 132: Jahrbücher der Zentralanstalt für Meteorologie und Geodynamik. Amtliche Veröffentlichung. Jahrgang 1925, Neue Folge, Band 62 Pp. xx+A42+B54+C42+D11. (Wien)

Field Museum of Natural History. Zoological Series, Vol. 15, Part 3: The Marine Fishes of Panama By Seth E. Meek and Samuel F. Hildebrand. (Publication No 249.) Pp. xxiii-xxxi+709-1045+plates 72-102. Zoological Series, Vol 12, No. 15: A new Genus of Aquatic Rodents from Abyssinia By Wilfrid H Osgood. (Publication No 250.) Pp 183-189+plate 15. Zoological Series, Vol. 12, No. 16. Reptiles collected in Salvador for the California Institute of Technology By Karl P Schmidt. (Publication No. 251.) Pp. 191-201. Zoological Series, Vol. 12, No. 17: Notes on South American Caimans. By Karl P. Schmidt. Reports on Results of the Captain Marshall Field Expeditions (Publication No. 252.) Pp. 203-231+plates 16-21. (Chicago)

Field Museum and the Child. an Outline of the Work carried on by Field Museum of Natural History among School Children of Chicago through the N. W. Harris Public School Extension and the James Nelson and Anna Louise Raymond Public School and Children's Lectures. Pp. 34+8 plates. (Chicago)

Library of Congress. Report of the Librarian of Congress for the Fiscal Year ending June 30, 1928. Pp. vi+302+4 plates. (Washington, D C.: *Government Printing Office*)

Department of Commerce: Bureau of Standards. Research Paper No. 39: Reflecting Power of Beryllium, Chromium and several other Metals. By W. W. Coblentz and R Stair. Pp. 343-351. 5 cents. Research Paper No. 43: Least Retinal Illumination by Spectral Light required to evoke the "Blue Arcs of the Retina." By Deane B. Judd. Pp. 441-451. 5 cents. (Washington, D.C.: Government Printing Office.)

Scientific Papers of the Institute of Physical and Chemical Research. No. 176: *A Band Absorption Spectrum of Iodine in an Extreme Ultra-Violet Region*. By Masamichi Kimura and Michika Miyanishi. Pp 33-42. 20 sen. Supplement, No 8: The approximate Content of Gallium in the Green Kaolin from Tanokami: On the Existence of Gallium in the Solar Chromosphere. By Satoyasu Iimori. Pp. 4. 10 sen. (Tokyo: Iwanami Shoten.)

Diary of Societies.

SATURDAY, MARCH 30

LEICESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemistry Section) (at Museum, Leicester), at 8.—Annual General Meeting.

TUESDAY, APRIL 2.

HULL CHEMICAL AND ENGINEERING SOCIETY (at Hull Photographic Society, Park Street, Hull), at 7.45.—H. E Copp: The Future of the Gas Industry.

WEDNESDAY, APRIL 3.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—Dr. L. H. Lampitt, E. B. Hughes, and H. S. Rooke: Furfural and Diastase in Heated Honey.—J. W. H. Johnson: Further Notes on Methods of Sewage and Water Analysis; Anti-Oxidation, and Stabilisation of Pollution. B. J. F. Dorrington and Dr. A. M. Ward. Potassium Cyanate as a Reagent for the Detection of Cobalt.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

ROYAL MICROSCOPICAL SOCIETY (Biological Section).

THURSDAY, APRIL 4.

LINNEAN SOCIETY OF LONDON, at 5. G M. Graham: The Natural History of the Victoria Nyanza.—Dr. G. P. Bidder: On the Classification of Sponges.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—Misuse of Language.

FRIDAY, APRIL 5.

INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section), at 7.—E W. Hill: Some Technical Considerations concerning Power Factor in Relation to Tariffs.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—Technical Film *showing the Production of Graham-Paige Cars in America*.

SATURDAY, APRIL 6.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Yorkshire District) (at Town Hall, Leeds), at 2.30.—Resumed Discussion on the Address by W. J. Hadfield on The Local Government Bill and the Municipal Engineer, with Particular Reference to the Compensation Clauses.